italkrane

THE HIGHEST LEVEL OF EXPLOSION PROTECTION

PRINCIPLES OF EX-PROTECTION

INTRODUCTION

In many industrial activities during the production, storage and handling of combustible substances, gases, vapors, mist and dust mixtures can be produced, generating explosive atmospheres which, coming into contact with oxygen and, if triggered, can cause explosions that can cause extensive damage to property and cause loss of life.

Industries such as oil, gas, chemicals, petrochemicals, pharmaceuticals, fertilizers, food, to name a few, are considered potentially exposed to the danger of explosion. Safety rules to prevent explosions have been developed around the world in the form of legislation and standards. The application of these standards guarantees compliance with high safety standards.

This publication aims to provide both professional operators and those interested in the subject with an overview, certainly not exhaustive, of the world of explosion protection and, in particular, of the most commonly used protection methods in our products, trying to give valid support. Knowledge of the main types of systems suggesting to the installer the indications regarding the criteria for recognizing, choosing and correctly installing **Italkrane** products and solutions.

Together with technical principles such as zone classification, temperature classes and protection methods, it provides information on the installation and operation of equipment in hazardous areas. This document cannot in any way replace the study of the applicable regulations in force.

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DEFINITIONS AND PHYSICAL PRINCIPLES

In the field of industrial plant safety, explosion protection is certainly one of the essential aspects. It is therefore essential to understand the principles underlying an explosion and its causal factors. The first chapter of our brochure aims to introduce readers to the basic principles and definitions in the field of explosion protection. An explosion is a rapid and violent phenomenon, resulting from a chemical reaction that involves the decomposition of an unstable substance (explosive), triggered by mechanical (shock, friction) or thermal (sparks, increase in temperature) causes, with the production of a considerable gaseous mass and heat in a very short time. An explosion can only occur when three factors are present at the same time.

THE THREE FACTORS OF AN EXPLOSION

An explosion is the sudden chemical reaction of a combustible substance with oxygen, resulting in the release of a high amount of energy.

An explosion can only occur when three factors are present at the same time: air (oxygen), combustible substance, ignition soure.

Combustible substance
Combustible substances may be present in the form of gases, mists, vapours or dusts. Safety-relevant parameters need to be considered to characterise hazard potentials.

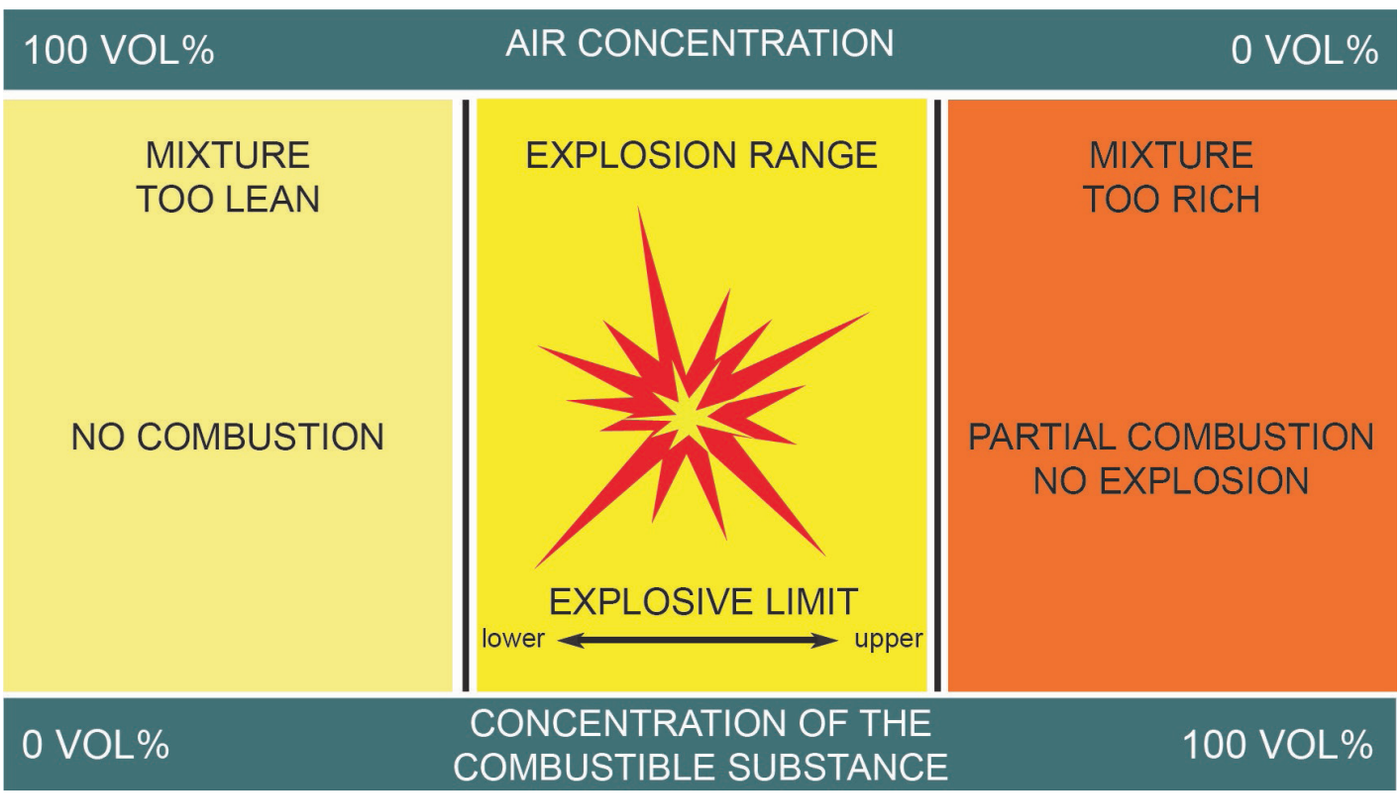
Explosive atmosphere
Explosive atmospheres contain a mixture of air and combustible gases, vapours, mists or dust in atmospheric conditions in which after ignition the combustion process spreads to the entire unburned mixture. In general, the atmospheric conditions are deemed to be ambient temperatures of -20 °C to +60 °C, a pressure range of 0.8 bar to 1.1 bar and an oxygen content of 21% in the air.

Flashpoint
The flashpoint is the minimum temperature at which a combustible liquid forms an ignitable mixture with air above the surface of the liquid (in normal air pressure conditions). If the flashpoint of a combustible liquid is far higher than the maximum temperatures which arise, an explosive atmosphere cannot be formed. However, the flashpoint of a mixture of various liquids may be lower than that of the individual components. Besides its boiling point, the flashpoint of a liquid is used for the classification (in the table below).

Criteria	Category
Flashpoint < 23°C and boiling point ≤ 35°C	1
Flashpoint < 23°C and boiling point > 35°C	2
Flashpoint ≥ 23°C and boiling point ≤ 60°C (for the purpose of the CLP Regulation, gas oil, diesel and light heating fuels, which have a flashpoint ranging from 55 °C to 75 °C, may be deemed to belong to Category 3.	3

Explosive limits

To form an explosive atmosphere, the combustible substance must be present in a certain concentration (in the diagram below). In the case of insufficient concentrations (lean mixture) or excessive concentrations (rich mixture) no explosion takes place, but a stationary or non-combustive reaction. It is only in the range between the lower (LEL) and upper (UEL) explosive limits that the mixture reacts explosively when ignited. The explosive limits depend on the ambient pressure and the percentage of oxygen in the air.



Ignition sources

To prevent ignition in a hazardous explosive atmosphere, all potential ignition sources must be identified and made non-threatening. Ignition of an explosive atmosphere can be caused by the following sources: flames, hot gases, hot surface, electrical system,lightning, high frequency of electomagnetic waves, optical radiation, ultrasound, ionising radiation, exothermal reactions, adiabatic compression and shock waves,static electricity, electrical equalising current.

In the table below the explosive limits of specific gases and vapors.

Substances	Acetylene	Petrol	Ethylene	Benzene	Fuel oil	Methane	Propane	Hydrogen	Carbon disulphide
Lower exp. limit (vol. %)	2.3	~ 0.6	2.4	1.2	~ 0.6	4.4	1.7	4.0	0.6
Upper exp. limit (vol. %)	100	~ 8.0	32.6	8.0	~ 6.5	17.0	10.8	77.0	60.0

Minimum ignition energy
To ignite a potentially explosive atmosphere. It is necessary to provide a specific amount of energy that depends on the nature of the atmosphere itself. The minimum ignition energy is between 10 and 5 joules for hydrogen and up to a few joules for some powders.

Integrated explosion protection
The principle of integrated explosion protection requires that all explosion protection measures must be carried out in a fixed order, with a distinction between primary, secondary and tertiary (constructive) protection measures.

AVOIDING THE FORMATION OF EXPLOSIVE ATMOSPHERE 1	Primary explosion protection includes all measures that prevent the formation of a dangerous explosive atmosphere: prevention is always better than protection! These precautions should therefore always be implemented first. Below are the main protection measures to be adopted: avoid combustible substances (alternative technologies); inertization (addition of nitrogen, carbon dioxide, etc.); limitation of concentration by natural or artificial ventilation.
AVOIDING THE IGNITION OF HAZARDOUS EXPLOSIVE ATMOSPHERE 2	Since the risks of explosion cannot be eliminated or excluded but only minimized by measures to prevent the formation of explosive atmospheres, it is necessary to take every action to prevent the ignition of explosive atmospheres. The level of safety required for these actions depends on the likelihood of danger in the workplace.
CONFINING EXPLOSION IMPACT TO A NEGLIGIBLE EXTENT 3	If the formation of a dangerous explosive atmosphere cannot be safely prevented and its ignition cannot be ruled out, measures must be taken that make the consequences of an explosion negligible. The following precautions can be taken: Flame retardant or surge resistant design; pressure release and compensation equipment; suppression of explosions with extinguishing devices. The requirements of electrical equipment for explosive atmospheres are complex and regulated by directives, national and international standards that must be observed to ensure the best possible degree of safety.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REGULATORY REQUIREMENTS

This chapter aims to provide the reader with an overview, summarizing the main legal requirements, international (IECEx), European Union (ATEX) and North American (NEC) recommendations The requirements of electrical equipment for explosive atmospheres are the most varied: national and international regulations, directives and standards must be observed and ensure maximum safety. The following chapter summarises the main regulatory requirements and recommendations worldwide, in the European Union and in North America to provide the reader with an overview.

EXPLOSION PROTECTION WORLDWIDE

The International Electrotechnical Commission (IEC) is responsible for global standards in the field of electrical engineering. IEC publications regarding explosion protection of electrical equipment and installations are prepared by the TC31 Technical Committee and are considered recommendations. In recent years, the regulations for areas at risk of gas explosion were contained in series 60079 and those for areas at risk of dust explosion in series 61241. Since many requirements are identical for both categories of substances, the two families of standards have now been grouped according to the IEC 60079 standard. The various methods for ensuring the protection of equipment against explosion are called protection modes and are described in the various sections of IEC 60079. These construction standards are recognized in many countries (see table in the next page). Systems and installations operating in hazardous areas must be classified according to the degree of danger to which they may be exposed in relation to the likelihood of the formation of explosive atmospheres.

The IEC has drafted two standards for this purpose:

- IEC 60079-10-1: Classification of areas – Explosive gas atmospheres.
- IEC 60079-10-2: Classification of areas – Explosive dust atmospheres.

Further standards are available for the installation and operation of electrical systems:

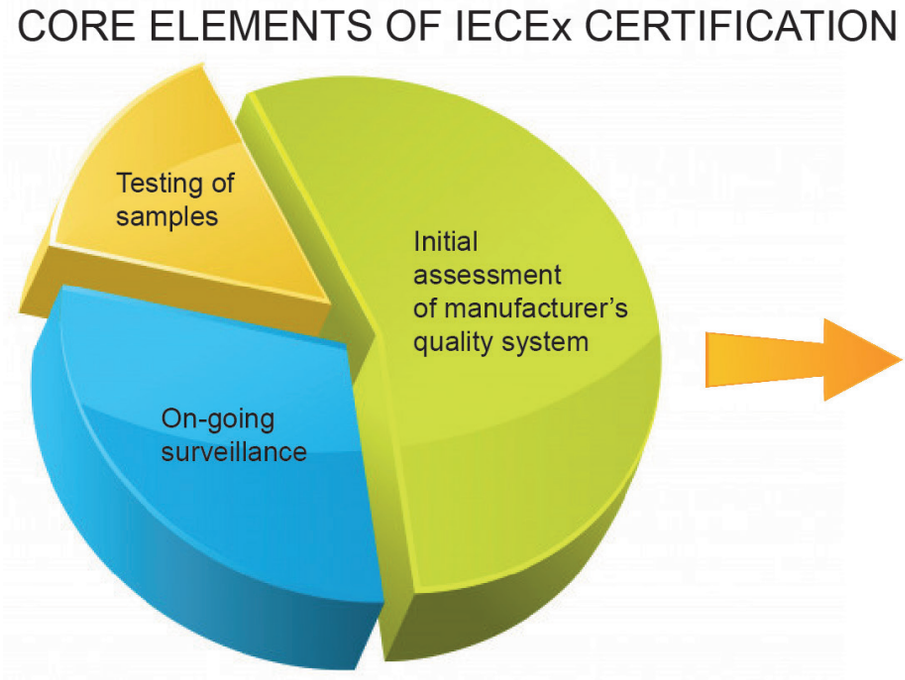
- IEC 60079-14: Electrical installations design, selection and erection.
- IEC 60079-17: Electrical installations inspection and maintenance.
- IEC 60079-19: Equipment repair, overhaul and reclamation.

In 2016 standards for non-electrical equipment for use in explosive atmosphere were published:

- ISO 80079-36: Non-electrical equipment for explosive atmospheres – basic method and requirements.
- ISO 80079-37: Non-electrical equipment for explosive atmospheres – non-electrical pro tection type constructional safety “c”, control of ignition sources “b”, liquid immersion “k”.
- ISO/IEC 80079-38: Equipment and components in explosive atmospheres in underground mines

However, national regulations may differ from the IEC standards. For this reason, their applicability in the respective countries must be verified. Since this involves a long development and approval process, especially at a global level, it seemed appropriate to subject the approval conditions of electrical equipment to international regulations, thus allowing global free movement of goods on the basis of neutral certificates with respect to the individual nation or region. Furthermore, consistent standards should ensure maximum safety of Ex products throughout their life cycle. IEC has therefore introduced a procedure with the aim of creating a globally recognized certification: the IECEx Scheme.

	IEC	EN
Equipment – General requirements	IEC 60079-0	EN 60079-0
Equipment protection by flameproof enclosures “d”	IEC 60079-1	EN 60079-1
Classification of areas – Explosive gas atmospheres	IEC 60079-10-1	EN 60079-10-1
Classification of areas – Explosive dust atmospheres	IEC 60079-10-2	EN 60079-10-2
Equipment protection by intrinsic safety “i”	IEC 60079-11	EN 60079-11
Equipment protection by pressurized room “p” and artificially ventilated room “v”	IEC 60079-13	EN 60079-13
Electrical installations design, selection and erection	IEC 60079-14	EN 60079-14
Equipment protection by type of protection “n”	IEC 60079-15	EN 60079-15
Artificial ventilation for the protection of analyser(s) houses	IEC/TR 60079-16	
Electrical installations inspection and maintenance	IEC 60079-17	EN 60079-17
Equipment protection by encapsulation “m”	IEC 60079-18	EN 60079-18
Equipment repair, overhaul and reclamation	IEC 60079-19	EN 60079-19
Equipment protection by pressurized enclosure “p”	IEC 60079-2	EN 60079-2
Intrinsically safe electrical systems	IEC 60079-25	EN 60079-25
Equipment with equipment protection level (EPL) Ga	IEC 60079-26	EN 60079-26
Protection of equipment and transmission systems using optical radiation	IEC 60079-28	EN 60079-28
Gas detectors – Performance requirements of detectors for flammable gases	IEC 60079-29-1	EN 60079-29-1
Gas detectors – Selection, installation, use and maintenance of detectors for flammable gases and oxygen	IEC 60079-29-2	EN 60079-29-2
Gas detectors – Guidance on functional safety of fixed gas detection systems	IEC 60079-29-3	EN 60079-29-3
Gas detectors – Performance requirements of open path detectors for flammable gases	IEC 60079-29-4	EN 60079-29-4
Electrical resistance trace heating – General and testing requirements	IEC 60079-30-1	EN 60079-30-1
Electrical resistance trace heating – Application guide: design, installation, maintenance	IEC 60079-30-2	EN 60079-30-2
Equipment dust ignition protection by enclosure “t”	IEC 60079-31	EN 60079-31
Electrostatics hazards – guidance	IEC/TS 60079-32-1	CLC/TR 60079-32-1
Electrostatics hazards – Tests	IEC 60079-32-2	EN 60079-32-2
Equipment protection by special protection “s”	IEC 60079-33	CLC/TR 60079-33
Intrinsically safe systems with electronically controlled spark duration limitation	IEC/TS 60079-39	CLC IEC/TS 60079-39
Requirements for process sealing between flammable process fluids and electrical systems	IEC TS 60079-40	
Electrical safety devices for the control of potential ignition sources for Ex-Equipment	IEC TS 60079-42	
Equipment in adverse service conditions	IEC TS 60079-43	
Equipment assemblies	IEC TS 60079-46	
Equipment protection by powder filling “q”	IEC 60079-5	EN 60079-5
Equipment protection by liquid immersion “o”	IEC 60079-6	EN 60079-6
Equipment protection by increased safety “e”	IEC 60079-7	EN 60079-7
Material characteristics for gas and vapour classification – test methods and data	ISO/IEC 80079-20-1	EN ISO/IEC 80079-20-1
Material characteristics – Combustible dusts test methods	ISO/IEC 80079-20-2	EN ISO/IEC 80079-20-2
Non-electrical equipment for explosive atmospheres – basic method and requirements	ISO 80079-36	EN ISO 80079-36
Non-electrical equipment for explosive atmospheres – non-electrical protection type of protection constructional safety “c”, control of ignition sources “b”, liquid immersion “k”	ISO 80079-37	EN ISO 80079-37
Safety devices required for the safe functioning of equipment with respect to explosion risks		EN 50495



IECEx Quality Assessment Report Summary

INTERNATIONAL ELECTROTECHNICAL COMMISSION
IEC Certification System for Explosive Atmospheres
for rules and details of the IECEx Scheme visit www.iecex.com

QAR Ref. No.:	FR/INE/QAR11.0005/05	Page 1 of 1
QAR Free Ref. No.:	201285	Status: Issued
Details of change:	Renewal audit	Date of issue: 2020-12-14
Site(s) audited:	ARIET Via Monza, 13 I-20060 BUSSERO (MI) ITALY Italy	Valid until: 2023-05-25 Audit date: 2020-11-29
Issuing ExCB:	INE - INERIS	
Manufacturer:	ARIET Via Monza, 13 I-20060 BUSSERO (MI) ITALY	
Location of Manufacturer:	Italy	
Product Information:	Electric equipment (brakes, push buttons, control units, siren, heater, ...)	
Protection concept:	d, e, m, t	

Related QARs:

FR/INE/QAR11.0005/00	FR/INE/QAR11.0005/01	FR/INE/QAR11.0005/02
FR/INE/QAR11.0005/03	FR/INE/QAR11.0005/04	FR/INE/QAR11.0005/05
FR/INE/QAR11.0005/06	FR/INE/QAR11.0005/07	FR/INE/QAR11.0005/08

Related Certificates (manual insertion)::

Related Certificates (automatic linking)::

Related Certificates for previous versions:

IECEx INE 11.0027X Issue: 0	IECEx INE 12.0007X Issue: 0	IECEx INE 12.0016X Issue: 0
IECEx INE 12.0059X Issue: 0	IECEx INE 16.0056X Issue: 0	

Comments:

THE IECEx CONFORMITY ASSESSMENT SYSTEM

In the early 1990s an IEC work- ing group, the WGEx, was formed. This was the starting point for the investigation of a possible implementation of a global certification system for the field of explosion protection based on the IEC standards for equipment for use in explosive atmospheres, which were in existence worldwide. The first official meeting for the establishment of a new IEC conformity assessment system (IECEx) took place in June 1996.
When it was established, in line with the IECEE System, the IECEx System only focussed on the drafting and mutual acceptance of test reports for equipment that had been tested for use in explosive atmospheres (IECExTest Reports (ExTRs)) of the participating IECEx testing organisation.

The basis for this Certificate of Conformity (CoC) issued by an IECEx certification body (ExCB) was the test report (ExTR) of an IECEx test laboratory (ExTL), and, as an added element, an audit of the manufacturer's quality management system. Unlike the existing national and regional approvals systems, where the paper original of the approval certificate is the decisive document, the IECEx System used an EDP supported approvals system from the outset.

Only the document shown in the system is the original. In the meantime the IECEx Conformity Assessment System is not only a system for the testing and approval of electrical equipment for use in explosive atmospheres, but it has extended its activities to include international services or systems.

The rulings now cover:

- the certification of Ex equipment ,
- the certification of Ex service providers and
- the certification of Ex personnel competence.

EXPLOSION PROTECTION IN THE EUROPEAN UNION

Explosion protection is governed by directives and standards in the European Union.

Directives

In 1976 the Council of the European Community established the basis for the free movement of explosion-protected electrical equipment within the European Union with its “Directive on the harmonisation of the laws of the member states concerning electrical equipment for use in potentially explosive atmospheres (76/117/EEC)”. This directive has since been continuously adapted to state-of-the-art standards by means of single and supplementary directives, which however only concerned electrical equipment. Full harmonisation and extension to all types of equipment, both electrical and non-electrical, was achieved in 1994 by the new 94/9/EC (ATEX) directive. This was followed in 1999 by the 1999/92/EC directive, which governs operation in hazardous areas and defines safety measures for the persons working in those areas. In February 2014, Directive 2014/34/EU (ATEX) was published. Actual implementation with regards to equipment certification took place on 20 April 2016, replacing Directive 94/9/EC.

Standards

The European EN 50014 – EN 50020 electrical equipment standards were issued in 1978 and replaced the previous national standards for this equipment valid across Europe. Aside from the electrical equipment standards (published by the European Committee for Electrotechnical Standardization CENELEC), the European Committee for Standardization (CEN) has drafted respective standards for non-electrical explosion-protected equipment. According to an agreement between the European Committee for Electrotechnical Standardization CENELEC and the International Committee for Electrotechnical Standardization IEC, international standards for electrical equipment have generally been adopted by CENELEC as they stand. The EN 50014 series defining requirements for equipment in explosive gas atmospheres has been gradually replaced by the EN 60079 series (at international level IEC 60079). The requirements of protection types for areas with combustible dust were contained in the IEC 61241 series. In Europe these EN 61241 standards replace the former EN 50281 series. However, since most requirements for gas and dust are similar, they are compiled under the series IEC or EN 60079 (see Table 3). After publication of Directive 94/9/EC in Europe, construction regulations for non-electrical equipment were also specified by the EN 13463 standard series. Some protection principles for electrical equipment were adopted, although amendments were made to address the special requirements of non-electrical equipment. Published in 2016, standards ISO 80079-36 and -37 have been adopted as EN ISO 80079-36 and -37 and supersede the standard series EN 13463. Other important harmonised standards on explosion protection worthy of mention are EN 1127-1 and -2. They set out methods by which hazards are identified and assessed and outline the respective protection measures. Both preventive explosion protection (avoiding explosive atmospheres and effective ignition sources) and constructive explosion protection (containing explosion effects) are addressed. With the aim of preventing ignition sources as a protective measure, all ignition sources are described and possible measures for their avoidance defined. While Part 2 is relevant for mines, Part 1 deals with other areas (above ground).

- EN 1127-1: Explosive atmospheres – Explosion protection, Part 1: basic principles & method
- EN 1127-2: Explosive atmospheres – Explosion protection, Part 2: basic principles & method in mines

INSTALLATION AND OPERATION

Directive 1999/92/EC “Minimum requirements for improving the health and safety protection of workers potentially at risk from explosive atmospheres” explains the principles of the operation of systems in hazardous areas. It is thus directed at operators (employers). They must assess the explosion hazard, classify the system into hazardous zones and document all measures to protect employees in the explosion protection document.

Evaluation of explosion risks

When assessing explosion risks, the following should be taken into account:

- Likelihood and duration of the presence of the explosive atmosphere.
- Likelihood of ignition sources being present, activated, and becoming effective.
- Materials and methods used and their possible interaction.
- The extent of the expected impacts of explosions.

Zone classification

The operator must classify the areas in which explosive atmospheres may be present into zones. It should also ensure compliance with the directive stipulating the minimum requirements (in an organisational and technical respect).

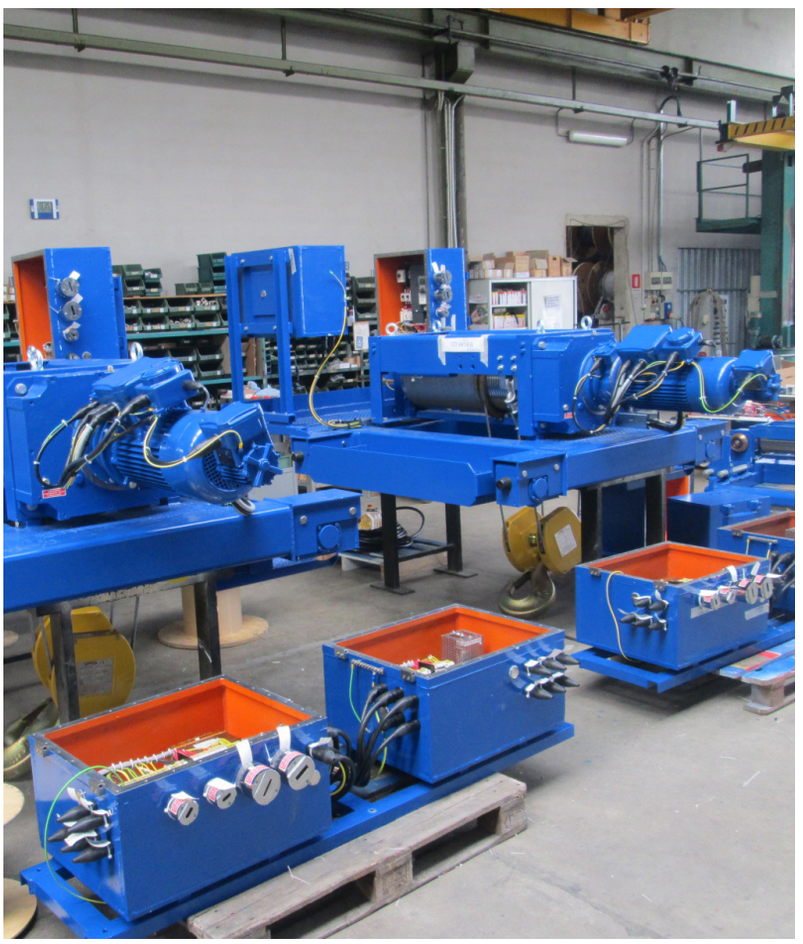
Explosion protection document

The explosion protection document must compulsorily contain details on the following aspects:

- Risk assessment.
- Protection measures adopted.
- Zone classification.
- Observance of minimum requirements. These are divided into organisational measures (e.g. instruction of employees) and technical measures (explosion protection measures).

Directive 1999/92/EC only contains minimum requirements, which may be freely extended on implementation in national legislation.

SELECTION OF EQUIPMENT



In 1994 EC Directive 94/9/EC “on the approximation of the laws of the Member States concerning equipment and protective systems for use in potentially explosive atmospheres” was issued to further standardise explosion protection in the EU. It was replaced in 2014 by EU Directive 2014/34/EU (ATEX). It stipulates the requirements for the quality of explosion-protected equipment and protective systems (e.g. by setting out provisions for conformity assessment, protective levels, certification, manufacture and quality assurance, operating manuals and declarations of conformity). It also prescribes the essential health and safety requirements which must be satisfied by manufacturers and importers. The directive thus ensures the free movement of goods within the European Union and must be adopted as it stands into national legislation.

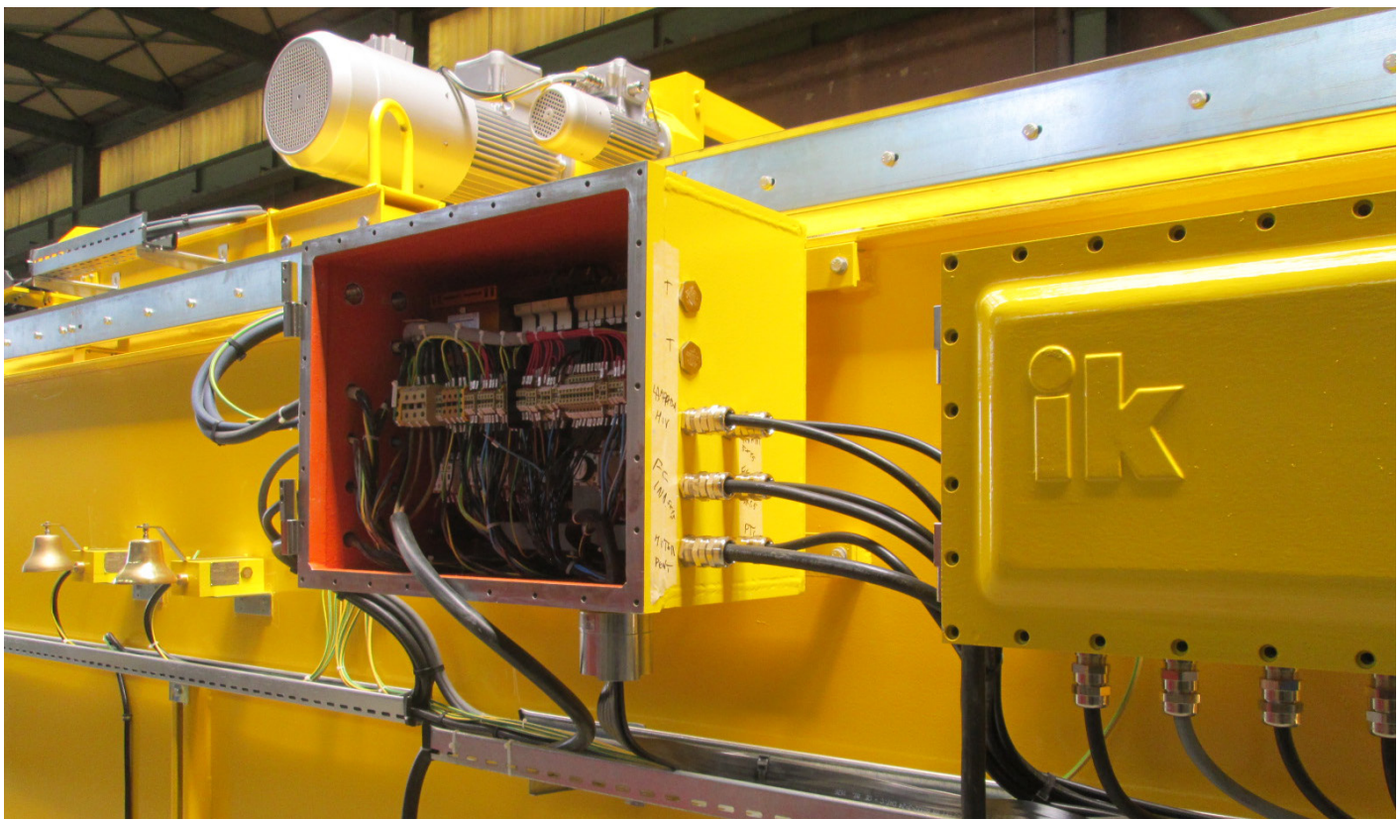
The directive applies to equipment, components and protective systems for use in hazardous areas. It also applies to safety, control and regulating apparatus used outside the hazardous area, if the latter is necessary in respect of explosion hazards for the safe operation of equipment in the hazardous area. The directive does not refer to established standards, but sets out fundamental safety requirements, which are deemed as binding quality requirements. Protection from other hazards (e.g. electric shock) which may be caused by this equipment must also be taken into account.

Equipment means machines, apparatus, fixed or mobile devices, control components and instrumentation thereof and detection or prevention systems which, separately or jointly, are intended for the generation, transfer, storage, measurement, control and conversion of energy and/or the processing of material and which are capable of causing an explosion through their own potential sources of ignition.

Component means any item essential to the safe functioning of equipment and protective systems but with no autonomous function.

Protective systems means devices other than components of equipment that are intended to halt incipient explosions immediately and/or to limit the effective range of an explosion. These are generally available in the market for use as autonomous systems.

A hazardous atmosphere means an atmosphere which could become explosive due to local and operational conditions.



Equipment categories
Manufacturers whose equipment may represent a potential ignition source and thus may cause an explosion must submit the latter for an ignition hazard assessment. In addition, measures corresponding to the fundamental safety requirements should be envisaged to preclude the risk of ignition by this equipment. The directive classes equipment for hazardous areas (with the exception of mine workings) into three categories with different levels of safety. The required protective measures are adopted to the respective required level of safety.

Conformity assessment and certification
Equipment for use in hazardous areas must first be submitted to the conformity assessment procedure prescribed by the directive before being put into circulation or on the market. Category 1 and M1 equipment must be submitted to a type approval test and certification by a notified inspection authority. The same applies to Category 2 and M2 electric equipment and combustion engines. Manufacturers can determine and document conformity with the directive requirements for other non-electric equipment in this category and for Category 3 equipment. The certificates from a notified inspection authority are recognised throughout the EU. Existing EC type examination certificates continue to retain their validity under the new EU Directive 2014/34/EU.

Marking
EU Directive 2014/34/EU requires special marking:

- CE marking.
- Symbol with group, category and additional letter G or D.

Operating instructions
The manufacturer's operating instructions must clearly define the intended use of the equipment by the operator. Minimum requirements of operating instructions include details on safe commissioning, use, mounting and dismantling, upkeep (maintenance and fault clearance) and safe setting-up. It may also be necessary to specify special conditions for safe use (including information on improper use).

Equipment and systems may only be put on the market if they bear the CE mark and the manufacturer's operating instructions and declaration of conformity are enclosed. The CE mark and written EU declaration of conformity confirm the product's compliance with all requirements and assessment procedures stipulated in the EU directives.

TRADITIONAL CLASSIFICATION OF HAZAROUS AREAS IN NORTH AMERICA		
Gases, vapours or mist Class I classification	**Dust Class II classification**	**Fibres and lint Class III classification**
NEC 500 & CEC J18	NEC 500 & CEC J18	NEC 500 & CEC J18
Division 1 Areas in which dangerous concentrations of incendive gases or vapours • may be present in normal operating conditions • may frequently arise during re pair and maintenance work • may arise during operational disruptions or fault conditions and at the same time faults occur on electric equipment which lead to a source of ignition.	Division 1 Areas in which dangerous concentrations of explosive dust atmospheres • may be present in normal operating conditions • may arise during operational disruptions or fault situations and at the same time faults occur on electric equipment which lead to a source of ignition and areas with a dangerous quantity of conductive dust (Group E).	Division 1 Areas in which flammable fibres and lint occur or are processed.
Division 2 Areas in which dangerous concentrations of incendive gases or vapours are kept in closed containers or systems and which can only be released as a result of fault conditions.	Division 2 Areas in which dangerous concentrations of explosive dust atmospheres can only be released in fault conditions.	Division 2 Areas in which flammable fibres are stored or handled differently than in the production process.

EXPLOSION PROTECTION IN NORTH AMERICA

The basic principles of explosion protection are the same all over the world. Nevertheless techniques and systems have been developed in North America that differ considerably from the IEC system. The differences, for instance, can be noted in the classification of hazardous areas, equipment design and the installation of electrical systems.

INSTALLATION AND OPERATION

In the USA the National Electrical Code (NEC) and in Canada the Canadian Electrical Code (CEC) apply to electrical equipment used on hazardous industrial premises. These have the character of installation regulations for electrical facilities in all areas and refer to a number of further standards of other institutions which contain specifications for the construction and installation of suitable equipment.

In North America, hazardous atmospheres are termed “hazardous (classified) locations”. Traditionally, hazardous areas are classified into “Class” and “Divisions” in North America. They comprise areas in which combustible gases, vapours or mists (Class I), dusts (Class II) or fibres or lint (Class III) may be present in dangerous quantities. Based on the likelihood or duration of the presence of these substances, the hazardous locations are traditionally subdivided into Division 1 and Division 2.

In 1996 the IEC classification system (zone classification) was also introduced for Class I. This amendment was implemented in Article 505 of the NEC, wherein users may choose the optimum system in terms of technology and economic efficiency. In 2005, Zones 20, 21 and 22 for areas with combustible dust (Article 506) were introduced. The IEC zone concept for Class I was also introduced in Canada (CEC edition 1988), whereby all newly installed systems must be classified according to this concept. In the 2015 edition of the CED the zone concept was also adopted for dust explosion hazardous areas.

SELECTION OF EQUIPMENT

The traditional North American classification system divides Class I flammable gases, vapours, mists and liquids into gas groups (Groups) A, B, C and D and Class II combustible dusts into Groups E, F and G. The letter A denotes the most hazardous gas group, while in IEC and according to the new classification pursuant to Article 505, Group IIC is the most hazardous group. Determination of the maximum surface temperature to Article 505 in the NEC according to six temperature classes T1 to T6 is in harmony with IEC – with an additional subdivision into temperature classes in the division system. The existing temperature class system was not changed in the CEC 2015 either.

The installation method for the zone concept pursuant to NEC 505 complies as far as possible to the traditional class/division systems. Besides the use of fixed pipelines and mineral type MI in Class I, Division 1 or Zone 1, approved cables are also allowed. Special cables may also be used in hazardous areas in Canada. Furthermore, various standards and regulations govern the construction and testing of explosion-protected electrical systems and equipment in North America. In the USA these are predominately the standards of the International Society for Measurement and Control (ISA), Underwriters Laboratories Inc. (UL) and the Factory Mutual Research Corporation (FM). In Canada the standards of the Canadian Standards Association (CSA) apply.

Enclosure protection types
The counterpart of IEC 60529, which determines the IP protection types for enclosures, is the Standard Publication No. 250 of NEMA (National Electrical Manufacturing Association) in the USA. These protection types cannot be exactly equated to those of the IEC as additional environmental influences (such as cooling liquids, cutting oils, corrosion, icing, hail) are addressed. It is to be noted that enclosure types 7, 8, 9 and 10 refer to enclosures for hazardous areas.

Certification
As a rule, electrical apparatus and equipment used on hazardous industrial premises are subject to approval in the USA and Canada. Exceptions include electrical equipment whose design, along with the nature of the explosive atmosphere in which it is used, precludes ignition. The responsible authorities decide whether such equipment is subject to approval. Equipment which has been developed and manufactured for use in hazardous locations must be tested and approved in the USA and Canada by notified inspection authorities.

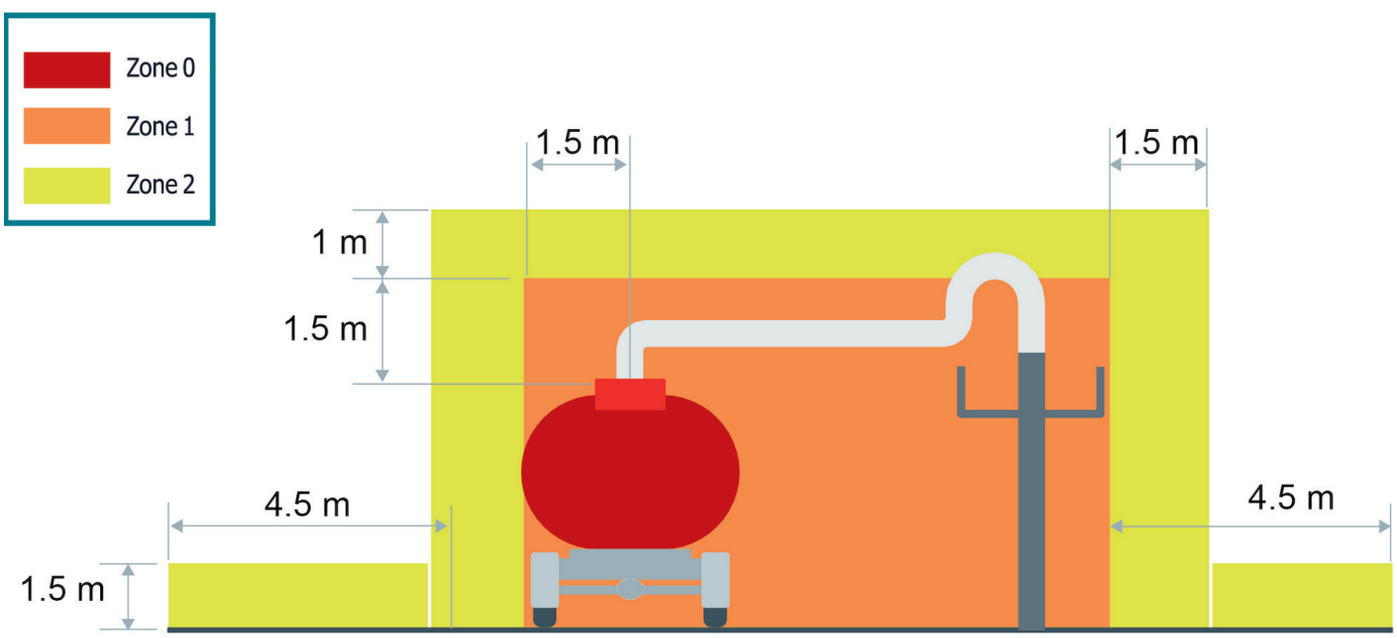
GROUPS	
Gas	**Dust**
A (acetylene)	E (metal)
B (hydrogen)	F (coal)
C (ethylene)	G (grain)
D (propane)	

TEMPERATURE CLASSES		
Ignition temperature of the gases and vapours in °C	**Temperature class**	**Maximum surface temperature on the equipment in °C**
> 450	T1	450
> 300 to 450	T2	300
> 280 to 300	T2A	280
> 260 to 280	T2B	260
> 230 to 260	T2C	230
> 215 to 230	T2D	215
> 200 to 300	T3	200
> 180 to 200	T3A	180
> 165 to 180	T3B	165
> 160 to 165	T3C	160
> 135 to 200	T4	135
> 120 to 135	T4A	120
> 100 to 135	T5	100
> 85 to 100	T6	85

TECHNICAL PRINCIPLES

As Ex areas are not equally hazardous, equipment is subject to different requirements. Chapter 3 provides more information about zone classification, equipment categories, the equipment protection level (EPL), different equipment groups, ignition temperature and temperature classes. You can find out about the various protection types and familiarise yourself with marking principles.

ZONE CLASSIFICATION		
GAS	Zone 0	an area in which an explosive gas atmosphere is present continuously or for long periods or frequently.
	Zone 1	an area in which an explosive gas atmosphere is likely to occur periodically or occasionally in normal operation.
	Zone 2	an area in which an explosive gas atmosphere is not likely to occur in normal operation but, if it does occur, it will exist for a short period only.
DUST	Zone 20	an area in which an explosive dust atmosphere, in the form of a cloud of dust in air, is present continuously, or for long periods or frequently.
	Zone 21	an area in which an explosive dust atmosphere, in the form of a cloud of dust in air, is likely to occur in normal operation occasionally.
	Zone 22	an area rea in which an explosive dust atmosphere, in the form of a cloud of combustible dust in air, is not likely to occur in normal operation but, if it does occur, will persist for a short period only.



ZONE CLASSIFICATION

Hazardous areas are classified into zones to facilitate the selection of appropriate electrical apparatus as well as the design of suitable electrical installations. Zone classification reflects the likelihood of the occurrence of an explosive atmosphere (see table on the previous page). Information and stipulations on zone classification can be found in IEC 60079-10-1 for gas explosion hazardous areas or in IEC 60079-10-2 for areas with combustible dust. There are also industry codes and national standards providing guidance or examples for area classification (see Annex K of IEC 60079-10-1).

The maximum risk potential has to be taken into account when classifying the hazardous areas into zones and determining the necessary protective measures. If there is no expert available in the company to assess the risk of explosion and determine the necessary measures, the advice of a competent authority should be sought. The equipment used in the defined hazardous zone must meet the requirements of the respectively assigned equipment category or equipment protection level.

EQUIPMENT CATEGORIES AND EQUIPMENT PROTECTION LEVEL (EPL)

Different safety requirements are demanded of the equipment used depending on the likelihood of the occurrence of an explosive atmosphere. The equipment protection level is matched to the hazard potential in the different zones. In Europe explosion-protected equipment is classified into categories by EU Directive 2014/34 (ATEX). At international level the equipment protection level (EPL) was introduced by IEC 60079 in 2007. Equipment should be designed with explosion protection measures of varying degrees according to its category or equipment protection level.

Equipment categories

Three categories are envisaged for equipment in hazardous areas – with the exception of firedamp-endangered mining works:

Category 1: equipment in this category is characterised by a very high degree of safety. Even in the rare event of equipment faults they must be safe and thus afford explosion protections that:

- upon the failure of one device protective measure, at least a second separate protective measure will guarantee the necessary safety.
- upon the occurrence of two different faults the necessary safety is afforded.

Category 2: equipment and systems offer a high degree of safety. The device explosion protection measures in this category are ensured in the case of frequent equipment faults or fault conditions (which can be typically expected).

Category 3: equipment in this category affords the necessary degree of safety in normal operation.

The additional letter G or D indicates the use of the equipment in gas explosion hazardous areas (G) or areas with combustible dust (D).

Two categories are envisaged for equipment used in firedamp-endangered mining works:

Category M1: Equipment in this category is characterised by a very high degree of safety. Even in the rare case of equipment faults they must be able to continue operating in the existing explosive atmosphere and thus display explosion protection measures so that:

- upon the failure of one device protective measure, at least a second separate protective measure will guarantee the necessary safety.
- upon the occurrence of two different faults the necessary safety is afforded.

Category M2: Category M2 equipment and systems offer a high degree of safety. Upon the occurrence of an explosive atmosphere it must be possible to switch off the equipment. The device explosion protection measures in this category afford the necessary degree of safety in normal operation – even in adverse operating conditions and in particular when exposed to rough handling and fluctuating environmental influences.

Equipment protection level (EPL):
Pursuant to IEC 60079-0 equipment for hazardous areas is classified into three protection levels.

EPL Ga or Da: equipment with a very high protection level for use in hazardous areas. In normal operation this equipment represents no risk of ignition in the event of predictable or rare faults/malfunctions.

EPL Gb or Db: equipment with a high protection level for use in hazardous areas which represents no risk of ignition in normal operation or in the event of predictable faults/malfunctions.

EPL Gc or Dc: equipment with an advanced protection level for use in hazardous areas. There is no risk of ignition during normal operation. The equipment has additional protective measures that ensure no risk of ignition in the event of typically predictable equipment faults.

The letters G and D denote whether the equipment and systems are suitable for gas explosion hazardous areas (G) or areas with combustible dust (D).

Two protection levels are defined for firedamp-endangered mining works.

EPL Ma: Equipment with a very high protection level that affords the necessary degree of safety. The equipment represents no risk of ignition in normal operation or in the event of predictable or rare faults/malfunctions – even if it is still in operation during a gas leak.

EPL Mb: Equipment with a high protection level that affords the necessary degree of safety. The equipment represents no risk of ignition in normal operation in the period between the occurrence of the gas leak and switching off the equipment.

The table below illustrates the application range for equipment in a specific category or with a specific protection level in the respective danger zones.

ZONE CLASSIFICATION AND EQUIPMENT ASSIGNMENT ACCORDING TO THEIR CATEGORY OR EPL PROTECTION LEVEL				
	Zone	**Duration of the presence of an explosive atmosphere**	**Equipment category**	**Equipment protection level (EPL)**
GAS	0	Constant, long-term, persistent	1G	Ga
	1	Occasionally	2G	Gb
	2	Rarely	3G	Gc
DUST	20	Constant, long-term Persistent	1D	Da
	21	Occasionally	2D	Db
	22	Rarely	3D	Dc

EQUIPMENT GROUPS

Classification pursuant to European Directive 2014/34/EU (ATEX)
The explosion-protected equipment is classified into two groups.

Equipment group I
Equipment intended for use in underground mining works and surface mining works that may be exposed to the hazard of firedamp and/or combustible dust.

Equipment group II
Equipment intended for use in other areas that may be exposed to an explosive atmosphere.

Electrical equipment for mining works in which in addition to firedamp, gases other than methane may occur, must adhere not only to Group I provisions, but also to the relevant provisions of Group II. Group II equipment is further classified according to application area into equipment for areas exposed to gases, vapours and mist and equipment exposed to dust.

Classification pursuant to IEC 60079

Two groups were formerly defined for explosion-protected equipment.

Group I
Equipment for firedamp-endangered mining works.

Group II
Equipment for hazardous areas – apart from mining.

Upon publication of IEC 60079-0 in 2007 Group III was introduced for dust explosion hazardous areas. Group II is reserved for equipment in gas explosion hazardous areas.

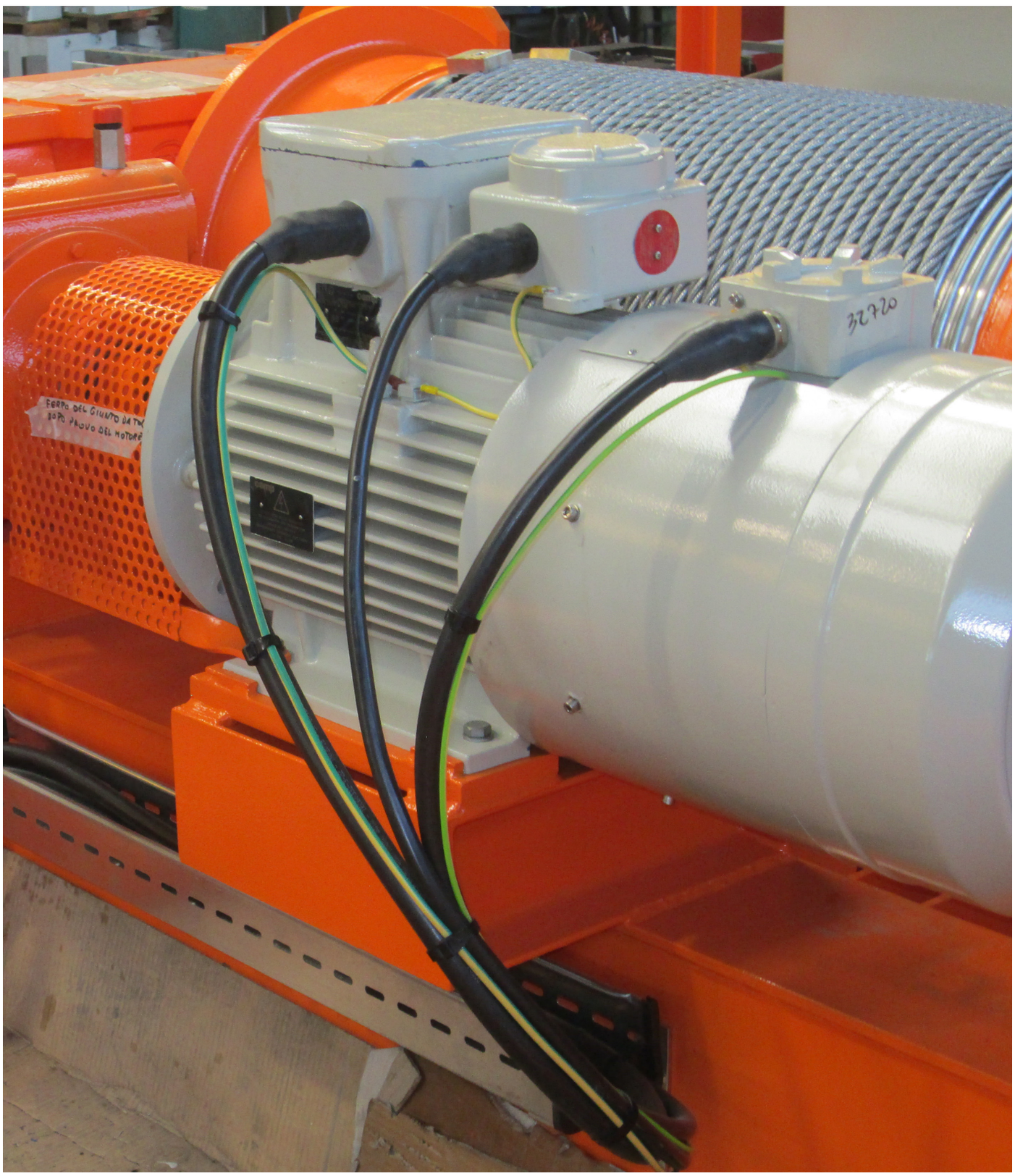
Group II
Equipment for gas explosion hazardous areas – apart from mining.

Group III
Equipment for dust explosion hazardous areas – apart from mining.

Electrical equipment in Group II (gas) is classified according to the characteristics of the explosive atmosphere (for which it is intended) into Groups IIA, IIB and IIC (first table in the next page). This assignment concerns the flameproof enclosure and intrinsic safety protection types. In the case of flameproof enclosures, it is based on the maximum experimental safe gap (MESG), which is a measure for the discharge behaviour of a hot flame through a narrow gap. The minimum ignition current (MIC) – a variable for the minimum ignition energy of emergent gases and vapours – is definitive for intrinsic safety. Equipment in dust explosion hazardous areas (Group III) is classified according to dust type into Group IIIA (combustible lint), IIIB (non-conductive dust) and IIIC (conductive dust). The latter two groups differ by specific electrical resistance, which for dusts in Group IIIC lies at a value less than or equal to 10^3 Ωm.

EQUIPMENT GROUP II CLASSIFICATION			
Group	Typical gas	Maximum experimental safe gap (MESG) in mm	Minimum ignition current ratio (in relation to methane)
IIA	Propane	> 0.9	> 0.8
IIB	Ethylene	from 0.5 to 0.9	from 0.45 to 0.8
IIC	Hydrogen	< 0.5	< 0.45

The substances and thus the hazardous areas in which they occur are therefore classified into groups. The equipment deployed must be designed for the requirements of the groups, which range in ascending order from IIA to IIC and IIIA to IIIC. Equipment that complies with IIC criteria may also be used in IIB and IIA areas. Group IIB equipment may also be used in IIA areas. IIA equipment may only be used in IIA areas. This applies likewise for Group IIIA, IIIB and IIIC equipment.



IGNITION TEMPERATURE AND TEMPERATURE CLASSES

The ignition temperature of an explosive gas atmosphere or dust cloud is the lowest temperature of a heated surface at which a mixture of air and combustible substances in the form of gas, vapour or dust may ignite in the specified conditions.

Combustible gases

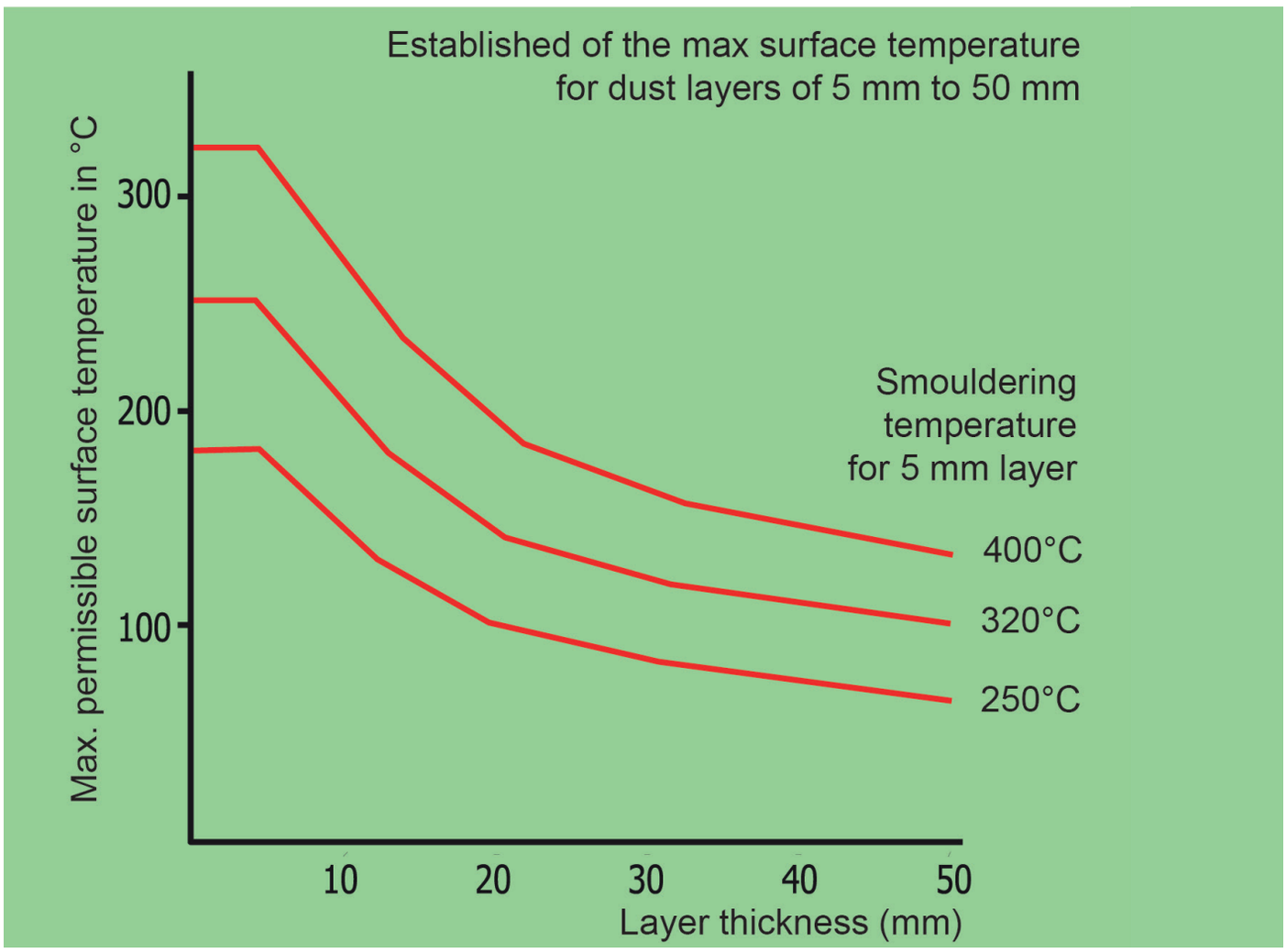
Combustible gases and vapours are classified into temperature classes according to their flammability. The maximum surface temperature of electrical equipment must always be lower than the ignition temperature of the gas or vapour and air mixture in which it is used. Of course, equipment classified in a higher temperature class (e.g. T5) may also be used for applications in which a lower temperature class is required (e.g. T2 or T3). North America has a system with further classification into temperature subclasses.

TEMPERATURE CLASSES		
Ignition temperature of gases and vapours in °C	**Temperature class**	**Maximum surface temperature of the equipment in °C**
> 450	T1	450
> 300 to 450	T2	300
> 200 to 300	T3	200
> 135 to 200	T4	135
> 100 to 135	T5	100
> 85 to 100	T6	85

Combustible dust

Combustible dusts are not classified into temperature classes. The minimum ignition temperature of the dust cloud is compared with the maximum surface temperature of the equipment, taking a safety factor into account. The maximum equipment surface temperature must not exceed two thirds of the dust cloud ignition temperature. Since dust can also settle on equipment, the ignition temperature of the dust layer (smouldering temperature) must also be considered. The smouldering temperature is the lowest temperature of a hot surface on which a dust layer of 5 mm can ignite.

Adjustment based on the maximum equipment surface temperature is performed with a safety factor of 75 K. As heat insulation increases with thicker layers the maximum permissible equipment surface temperature should be reduced accordingly. This is established according to the diagram (next page) in IEC 60079-14. If the layer is thicker than 50 mm, the smouldering temperature must be determined by laboratory tests. This also applies to layers thicker than 5 mm when the smouldering temperature is lower than 250 °C. Laboratory tests are also required when equipment is completely covered with combustible dust. Critical equipment surfaces may not be hotter than the lower of the two permissible surface temperatures with reference to the dust cloud and layer.



PROTECTION TYPES

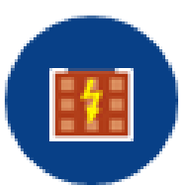
Explosion-protected equipment is predominantly used in locations with a threat of explosion. Explosion-protected electrical equipment for hazardous areas may be designed as per standard series IEC 60079 building provisions in various protection types. Protection types for non-electrical equipment are specified in the ISO 80079 standard series and formerly in EN 13463 in Europe.

The protection type used by a manufacturer for equipment mainly depends on its nature and function. Some protection types are available in different protection levels. They correspond to the equipment categories in Directive 2014/34/EU or the equipment protection level (EPL) in IEC 60079-0. In terms of intrinsic safety, an Ex ia version is available, although it is classified as Category 1 or EPL Ga. It may be installed in Zone 0. The Ex ib version corresponds to Category 2 or EPL Gb. It is suitable for Zone 1. Ex ic can be used as Category 2 or EPL Gc in Zone 2. In safety terms, all standardised protection types in a category or equipment protection level may be deemed equivalent. Tables “Protection types for electrical equipment in explosive gas atmosphere, Part. 1” and “Protection types for electrical equipment in explosive areas, Part. 2” provide an overview of the standardised protection types and describe the basic principle and customary use cases. The protection type symbols are simplified (Table “Marking pursuant to standard series IEC 61241 and IEC 60079) by integrating the protection types for dust explosion hazardous areas into the standard series 60079.

PROTECTION TYPES FOR ELECTRICAL EQUIPMENT IN EXPLOSIVE GAS ATMOSPHERES, PART 1

Diagram	Protection type according to IEC, EN, ISA and UL	Basic principles	Main application
	General requirements IEC 60079-0 EN 60079-0 UL 60079-0	This standard specifies the general requirements for explosionprotected electrical equipment and also details equipment marking.	
	Increased safety “e” IEC 60079-7 EN 60079-7 UL 60079-7	Additional measures are adopted in this case to afford a higher degree of safety for preventing impermissible high temperatures and the occurrence of sparks and flashovers inside or on outer parts of electrical equipment that do not occur in normal operation.	Terminal and connection boxes, control boxes for installing ex components (with a different protection type), squirrel cage motors, lights eb = use in Zone 1, 2 ec = use in Zone 2.
	Flameproof enclosure “d” IEC 60079-1 EN 60079-1 UL 60079-1	Parts which can ignite an explosive atmosphere are housed in an enclosure which withstands the pressure of an explosive mixture exploding inside the enclosure and prevents transmission of the explosion to the atmosphere around the enclosure.	Switchgear and control gear, control and display units, control systems, motors, transformers, heaters, lights da = use in Zone 0, 1, 2 db = use in Zone 1, 2 dc = use in Zone 2.
	Pressurised enclosure “p” IEC 60079-2 EN 60079-2 UL 60079-2	The formation of an explosive atmosphere inside an enclosure is prevented by maintaining a positive internal pressure of inert gas in relation to the surrounding atmosphere and, where necessary, by supplying the inside of the enclosure with a constant flow of inert gas to dilute combustible mixtures.	Switchgear and control cabinets, analysers, large motors pxb = use in Zone 1, 2 and Zone 21, 22 pyb = use in Zone 1, 2 and Zone 21, 22 pyb = use in Zone 2 and Zone 22.
	Intrinsic safety “i” IEC 60079-11 EN 60079-1 UL 60079-11	Equipment that is used in a hazardous area only contains intrinsically safe electric circuits. An electric circuit is intrinsically safe if no sparks or thermal effects are produced under specified test conditions (which include normal operation and specific fault conditions) which might result in the ignition of a specific explosive atmosphere.	Measurement and control technology, fieldbus technology, sensors, actuators ia = use in Zone 0, 1, 2 and Zone 20, 21, 22 ib = use in Zone 1, 2 and Zone 21, 22 ic = use in Zone 2 and Zone 22 [Ex ib] = associated electrical equipment installation in safe area.
	IEC 60079-25 EN 60079-25 UL 60079-25	Intrinsic safety evaluation for defined systems (equipment and cables).	Intrinsically safe systems.

PROTECTION TYPES FOR ELECTRICAL EQUIPMENT IN EXPLOSIVE AREAS, PART 2

Diagram	Protection type according to IEC, EN, ISA and UL	Basic principles	Main application
	Liquid immersion “o” IEC 60079-6 EN 60079-6 UL 60079-6	Electrical equipment or parts thereof are immersed in a protective fluid (such as oil), so that an explosive atmosphere cannot be ignited above or inside.	Transformers, starting resistors ob = use in Zone 1, 2. oc = use in Zone 2.
	Powder filling “q” IEC 60079-5 EN 60079-5 UL 60079-5	Filling the enclosure of electrical equipment with a fine granular packing material stops flashovers inside during intended operation igniting the explosive atmosphere around the enclosure. Ignition cannot result either from flames or due to increased temperatures on the enclosure surface.	Sensors, electronic ballast, transmitters q = use in Zone 1, 2.
	Encapsulation “m“ IEC 60079-18 EN 60079-18 UL 60079-18	Parts that may ignite an explosive atmosphere are embedded in sealing compound to stop ignition of the explosive atmosphere.	ma = use in Zone 0, 1, 2 and Zone 20, 21, 22. mb = use in Zone 1, 2 and Zone 21, 22. mc = use in Zone 2 and Zone 22.
	Protection type “n” IEC 60079-15 EN 60079-15 UL 60079-15	Electrical equipment cannot ignite a surrounding explosive atmosphere (during normal operation and under defined abnormal operating condi- tions).	All electrical equipment for Zone 2 nA = non-sparking device. nC = devices and components. nR = restricted breathing enclosure.
	Optical radiation “op” IEC 60079-28 EN 60079-28 UL 60079, 28	Appropriate measures prevent ignition of an explosive atmosphere by optical radiation.	Fibre optics / use in gas explosion hazardous areas There are three different methods: Ex op is = inherently safe optical radiation. Ex op pr = protected optical radiation. Ex op sh = optical radiation with interlock.
	Protection by enclosure “t” IEC 60079-31 EN 60079-31 UL 60079-31	Thanks to its tightness, dust cannot penetrate the enclosure or reduces it to a negligible degree. Ignitable apparatus can now be mounted in the enclosure. The enclosure temperature must not be sufficient to ignite the surrounding atmosphere.	Switchgear and control gear, control, connection, and terminal boxes, motors, luminaires ta = use in Zone 20, 21, 22. tb = use in Zone 21, 22. tc = use in Zone 22.

MARKING PURSUANT TO STANDARD SERIERS IEC 61241 & IEC 60079				
Standard Series 61241	**Symbol**	**Standard Series 60079**	**Symbol**	**Zone**
Protection via enclosure				
IEC 61241-1	tDA20, tDB20 tDA21, tDB21 tDA22, tDB22	IEC 60079-31	ta	20
			tb	21
			tc	22
Pressurised enclosure				
IEC 61241-4	pD21 pD22	IEC 60079-2	pxb	21
			pyb	21
			pzc	22
Intrinsic safety				
IEC 61241-11	iaD20 ibD21	IEC60079-11	ia	20
			ib	21
			ic	22
Encapsulation				
IEC 61241-18	maD20 maD21	IEC 60079-18	ma	20
			mb	21
			mc	22

PROTECTION TYPES FOR NON-ELECTRICAL EQUIPMENT IN EXPLOSIVE AREAS

Diagram	Protective type pursuant to ISO or EN	Basic principles	Main application
	General requirements ISO 80079-36 (formerly EN 13463-1)	This standard specifies the general requirements for explosion-protected electrical equipment and also details equipment marking.	
	Constructional safety “c” ISO 80079-37 (formerly EN 13463-5)	Proven technical principles are applied to equipment types which do not have any ignition source in normal operation, so that the risk of mechanical faults causing incendive temperatures and sparks is reduced to a negligible degree.	Couplings, pumps, gear drives, chain drives, conveyor belts
	Control of ignition source “b” ISO 80079-37 (formerly EN 13463-6)	Sensors are integrated into the equipment to detect imminent hazardous conditions and adopt countermeasures at an early stage before potential ignition sources become effective. The measures can be initiated automatically by means of a direct connection between the sensors and the ignition protection system or manually by issuing a warning to the opera- tor of the equipment.	Pumps, conveyor belts
	Liquid immersion “k” ISO 80079-37 (formerly EN 13463-8)	Ignition sources are rendered ineffective by immersion in a protective liquid or by constant moistening with a liquid film.	Submerged pumps, gears
	Flameproof enclosure “d” IEC 60079-1 (formerly EN 13463-3)	Parts that can ignite an explosive atmosphere are housed in an enclosure which withstands the pressure of an explosive mixture exploding inside the enclosure and prevents transmission of the explosion to the atmosphere around the enclosure.	Brakes, couplings
	Pressurised enclosure “p” IEC 60079-2 (formerly EN 60079-2)	The formation of an explosive atmosphere inside an enclosure is prevented by maintaining a positive internal pressure of inert gas in relation to the surrounding atmosphere and, where necessary, by supplying the inside of the enclosure with a constant flow of inert gas to dilute combustible mixtures.	Pumps
	Protection by enclosure “t” IEC 60079-31	Thanks to its tightness, dust cannot penetrate the enclosure or reduces it to a negligible degree. Ignitable apparatus can now be mounted in the enclosure. The enclosure temperature must not be sufficient to ignite the surrounding atmosphere.	Equipment exclusively for dust explosion hazardous areas

EN 60079-0
EXPLOSIVE ATMOSPHERES – PART 0
EQUIPMENT – GENERAL REQUIREMENTS

Electrical equipment for use in explosive atmosphere shall meet the general requirements of EN 60079-0 and the specific requirements of the type of protection in which it is designed. Under some circumstances, particularly harsh operating conditions, the effects of humidity, high ambient temperatures and other special demands require additional measures.Some of the main points are listed below.

Equipment grouping
Electrical equipment of Group I is intended for use in mines susceptible to firedamp. Electrical equipment of Group II is intended for use in areas where an explosive gas atmosphere is to be expected, other than mines susceptible to firedamp. Electrical equipment of Group II is subdivided according to the nature of the explosive atmosphere for which it is intended.

Group II subdivisions
- IIA, a typical gas is propane
- IIB, a typical gas is ethylene
- IIC, a typical gas is hydrogen

Electrical equipment of Group III is intended for operation in areas with an explosive dust atmosphere, other than mines susceptible to firedamp. Electrical equipment of Group III is subdivided according to the na- ture of the explosive atmos- phere for which it is intended.

Group III subdivision
- IIIA, combustible flyings
- IIIB, non-conductive dust
- IIIC, conductive dust

Temperatures
Electrical equipment shall be designed for use in a normal ambient temperature range of -20 to +40°C.

Mechanical strenght of equipment
The mechanical strength, suitability for the intended operating temperature range and the resistance to ageing of the materials used are verified by climatic conditioning and tests for resistance to impact and drop tests (see in the next table).

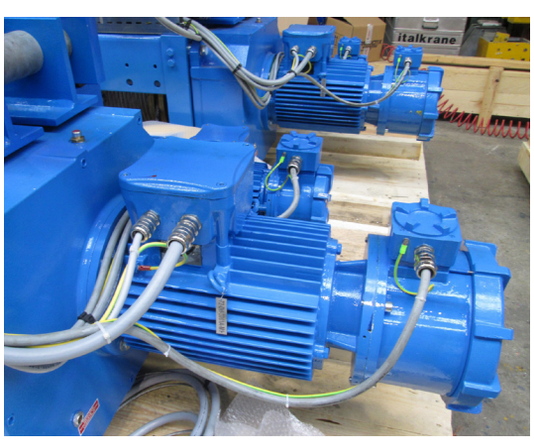
AMBIENT TEMPERATURES IN SERVICE AND ADDITIONAL MARKING		
Electrical equipment	**Ambient temperature in service**	**Additional marking**
Normal	Maximum: +40°C Minimum: -20°C	None
Special	Specified by the manufacturer	T_a or T_{amb} with the special range, e.g. -30°C ≤ T_a ≤ +40°C, or the symbol “X”

Electromagnetic and ultrasonic energy-radiating equipment
In order to prevent the ignition of an explosive mixture, the signals emitted from equipment shall be below the values stated in the standard. The specified limiting values shall also apply to lasers and other continuous light sources.

Enclosures and parts of enclosures
If plastics and light alloys are used, special requirements listed in the standard that apply specifically to enclosures shall be met.
To prevent an electrostatic charge, in the case of plastic enclosures, a material with a surface resistance of < 1 GOhm is used if the area specified in the standard is exceeded.

Special requirements
Depending on the type of protection, special requirements apply to fasteners and interlocks, bushings and connection pieces ,rotating machines, switchgear, fuses, plugs and sockets, luminaires and batteries.

TEMPERATURE CLASSES		
Ignition temperature of gases and vapours in °C	**Temperature class**	**Maximum surface temperature of the equipment in °C**
> 450	T1	450
> 300 to 450	T2	300
> 200 to 300	T3	200
> 135 to 200	T4	135
> 100 to 135	T5	100
> 85 to 100	T6	85



Ex-components
An Ex component is a part of electrical equipment or a module that is marked with the symbol “U” must not be used alone and requires additional consideration when incorporated into electrical equipment or systems for use in explosive atmospheres.

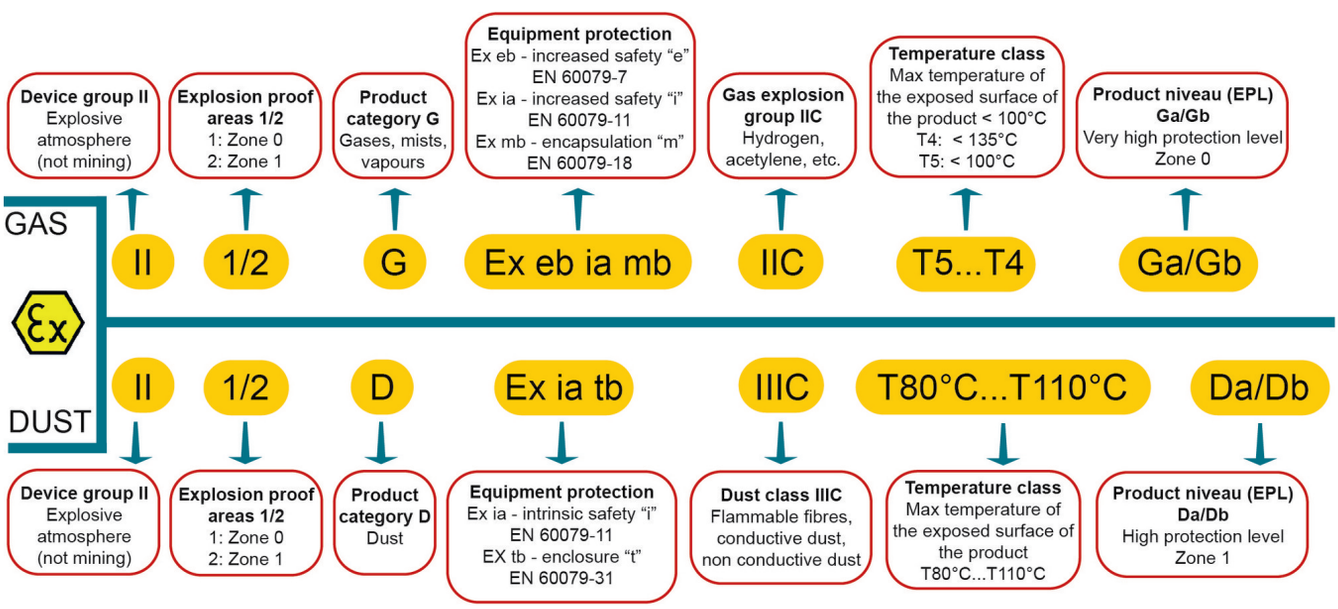
Cable entries
Cable entries must not render the special properties of the type of protection of the electrical equipment to which they are mounted ineffective and shall fulfil the requirements laid down in the standard.

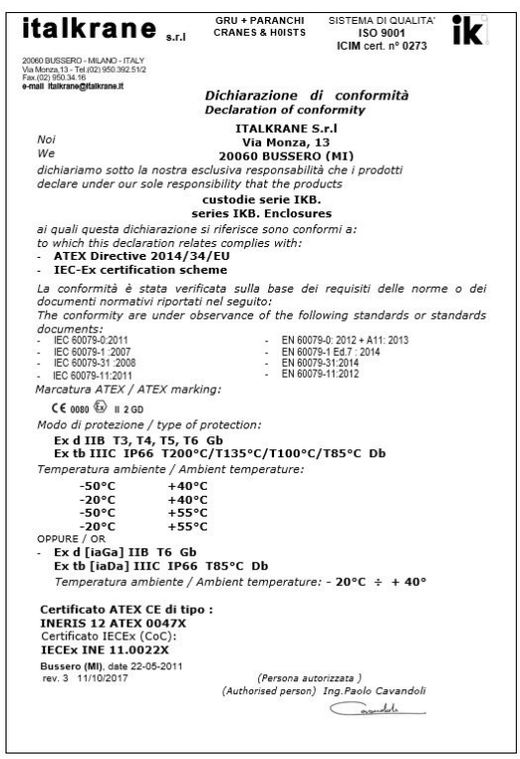
Marking

The electrical equipment shall be marked legibly on the main part on the exterior of the enclosure. The minimum requirements for the marking can be found in the standard. In this page there is an example of a marking.

Operating instructions

The operating instructions shall include all the information required for the installation, commissioning, use, assembly and dismantling and, where necessary, special instructions for use and a list of the standards, including the date of issue, with which the electrical equipment is declared to comply.





EN 60079-1
EXPLOSIVE ATMOSPHERES – PART 1
EQUIPMENT PROTECTION BY FLAMEPROOF ENCLOSURES “D”

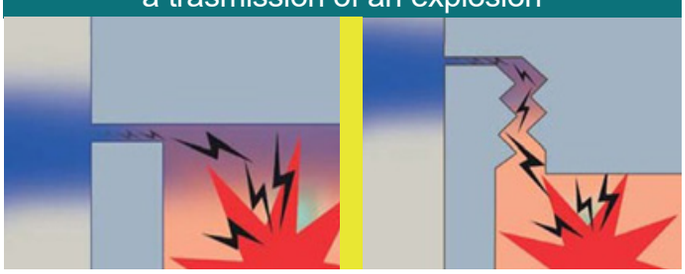
Scope

This part 1 of EN 60079 contains specific requirements for the construction and testing of electrical equipment in the type of protection Flameproof Enclosure “d” intended for use in explosive gas atmospheres. It supplements and modifies the general requirements of EN 60079-0.

Definition

Type of protection where the parts which can ignite an explosive gas atmosphere are built into a flameproof enclosure that can withstand the pressure developed during an internal explosion of an explosive mixture and prevents the transmission of the explosion to the explosive atmosphere surrounding the enclosure.

The flanged/threated joint prevents a trasmission of an explosion



Equipment Protection Level (EPL)

Electrical equipment with flame-proof enclosure “d” can be designed in various levels of protection, which determine the overall equipment protection level:

a) Level of Protection “da” (EPL “Ma” or “Ga”);
b) Level of Protection “db” (EPL “Mb” or “Gb”);
c) Level of Protection “dc” (EPL “Gc”).

Requirements for level of protection “da”

The level of protection “da” only applies to catalytic sensors or portable combustible gas detectors. The maximum free internal volume shall not exceed 5 cm³.

Requirements for level of protection “db”

The new level of protection “db” replaces and describes the previous flameproof enclosure “d”.

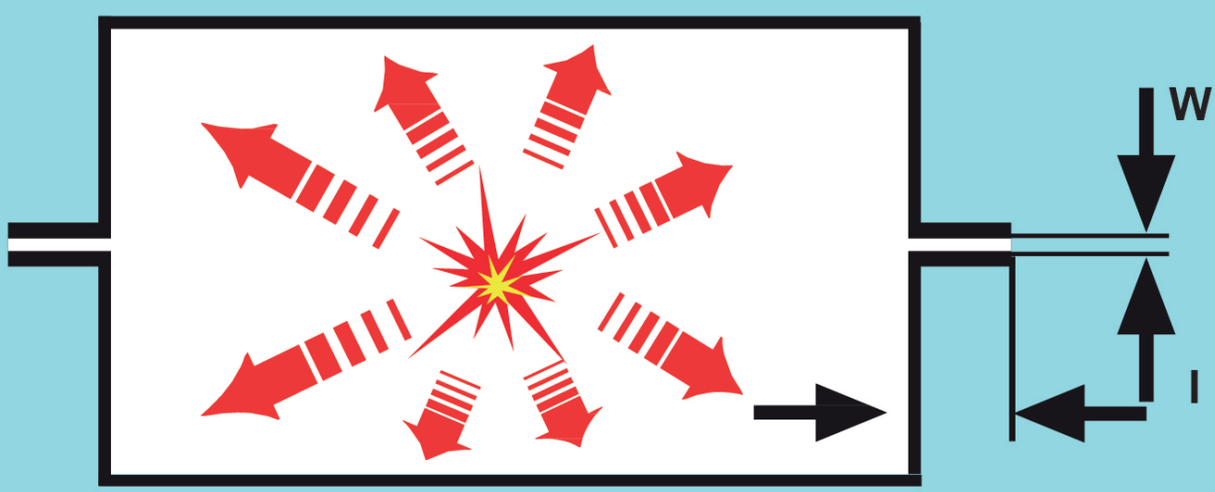
Requirements for level of protection “dc”

The level of protection “dc” describes a simplified flameproof encapsulation without the constructional requirements for, for example, the geometry of gaps. The maximum free internal volume shall not exceed 20 cm³.

General requirements

The flameproof encapsulation can be seen as a one-way street. An explosive atmosphere can enter into the enclosure, but, in the event of an explosion inside the enclosure, the transmission of the explosion to the explosive atmosphere surrounding the enclosure. As, due to the construction principle, there are normally gaps in flameproof enclosures, these gaps shall be such that an arc through these gaps is prevented. In particular, it is necessary to ensure that the gaps are not damaged mechanically. The geometry of gaps, the gaps and the width of joints shall vary according to the respective group (A, B, C). The values stated in the standard are only minimum requirements. The suitability shall be verified by experimental tests.

Principle of flameproof enclosures



The flameproof enclosure shall be able to safely withstand the pressure resulting from an explosion inside the enclosure. Depending upon the size, group and geometry, the pressures arising in the event of an explosion can vary considerably (< 5 bar to > 40 bar). If flameproof enclosures are used outside of the standard ambient temperature range (-20 °C to +40 °C), the suitability shall be tested in accordance with the method specified in EN 60079-1. Special attention shall be given to the fact that, as the ambient temperature changes, there may also be negative changes to the stability of enclosure parts. Because, when the internal compartment is divided up (e.g. by builtin equipment) and, in the event of an explosion, a precompaction of the remaining mixture and, as a result, increases in pressure may occur, the worst case scenarios shall be taken into consideration during experiments.

Walls and obstructions that could lead to a dynamic pressure with flange joints shall feature a minimum clearance from the joints. Oil and liquids that can form an explosive mixture with the air on decomposition must not, under any circumstances, be used in equipment in flameproof enclosures.

Equipment of Group IIC may also be used in the areas for Groups IIB and IIA. The temperature class of equipment denotes the permissible limiting temperature up to which the external surface of the equipment may heat up.

MINIMUM DISTANCE OF OBSTRUCTION FROM FLAMEPROOF “D” FLANGE OPENINGS

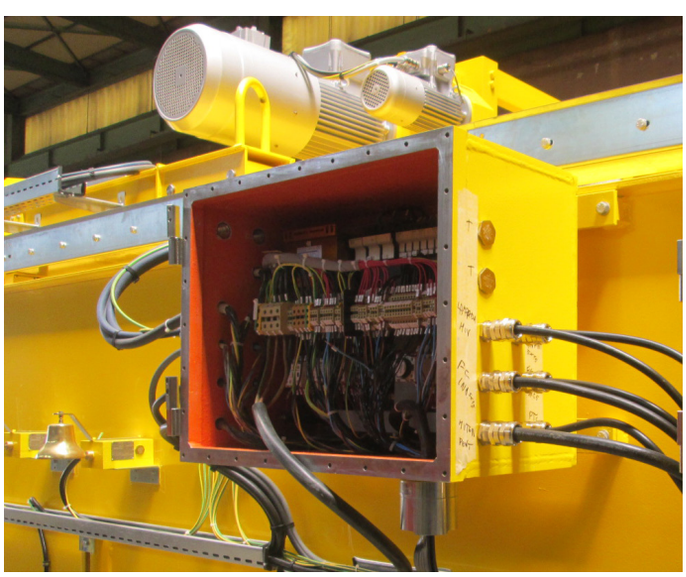
Gas group	Minimum distance
IIA	10 mm
IIB	30 mm
IIC	40 mm

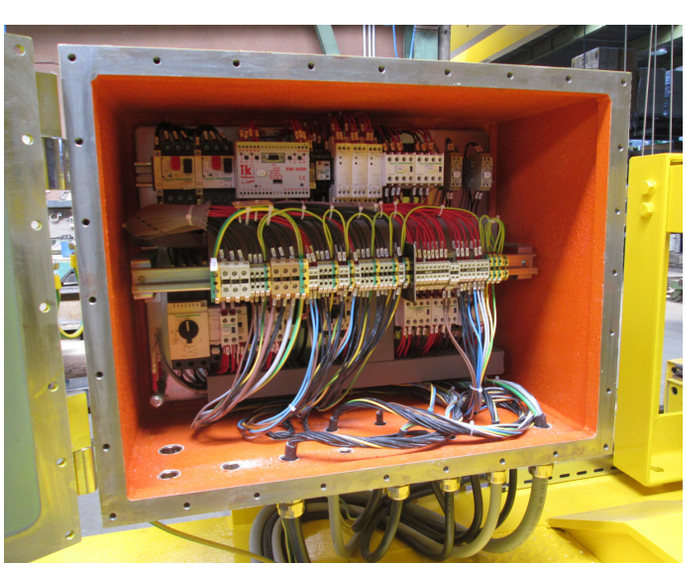
IEC 60079-14 limits the installation of equipment employing type of protection “d” that incorporates flanged (flat) joints. Specifically, the flanged joints of such equipment are not permitted to be installed closer to solid objects that are not part of the equipment.

Empty enclosures
The enclosures shall be marked in accordance with the requirements for the marking of Ex components according to EN 60079-0. The Ex marking must not be affixed to the exterior. The exterior of the enclosure may only be marked with the name of the manufacturer and identification features (e.g. type or serial number).

Cable entries
In addition to the requirements of EN 60079-0, cable entries in Ex-d enclosures shall satisfy the requirements for flameproof enclosures. Depending on the chosen concept, entry into the enclosure can either be made: directly (Ex-d cable entry or conduit) or indirectly (Ex-e connection box combined with Ex-d flameproof bushings).

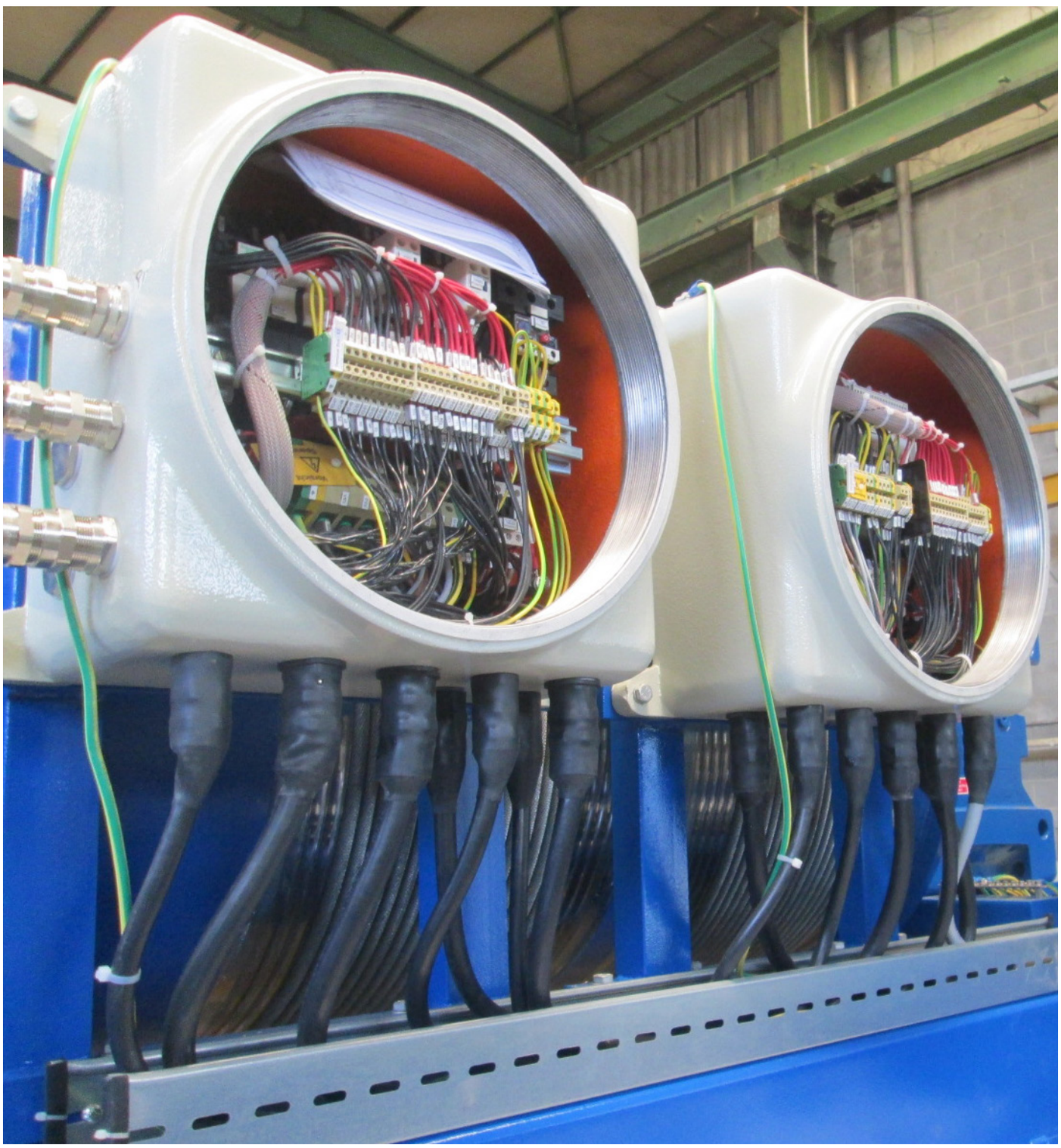
Cells and batteries for use in flameproof enclosures in the type of protection “d”
Irrespective of the type of electro-chemical cell used, the main task is to prevent the rehlease of a combustible mixture of electrolysis gases (normally hydrogen and oxygen) inside the flameproof enclosure. For this reason, the use of cells and batteries where the release of electrolysis gases (either due to natural ventilation or with a pressure-relief valve) is to be expected during normal operation is not permitted.





Examples of flameproof enclosure “d” applications

- Motors with slip rings and commutators
- Three-phase cage induction motors
- Switchgear with N/C and N/O contacts such as manual motor starters, circuit breakers, airbreak contactors
- Control devices
- Limit Switch
- Luminaires



EN 60079-7
EXPLOSIVE ATMOSPHERES – PART 7
EQUIPMENT PROTECTION BY INCREASED SAFETY “E”

Scope
This part 7 of IEC 60079 specifies the requirements for the design, construction, testing and marking of electrical equipment and Ex Components with type of protection increased safety “e” intended for use in explosive gas atmospheres. It supplements and modifies the general requirements of IEC 60079-0.

Definition
A type of protection applied to electrical equipment in which additional measures are applied so as to give increased security against the possibility of excessive temperatures and against the occurrence of arcs and sparks during the intended operation and under given extraordinary conditions.

Equipment protection level (EPL)
Electrical equipment and Ex components in the type of protection “e” can be designed with various levels of protection which determine the overall equipment protection level.

a) Level of Protection “eb” (EPL “Mb” or EPL “Gb”)
b) Level of Protection “ec” (EPL Gc).

Level of Protection “eb”
Rated voltage 11 kV rms AC or DC

This applies to the equipment specified in the standard and connections, conductors, windings, lamps and batteries, but not to electronic components.

Level of Protection “ec”
Rated voltage 15 kV rms AC or DC

This applies to the equipment specified in the standard and connections, conductors, windings, lamps and batteries, including semiconductors or electrolytic capacitors.

General requirements

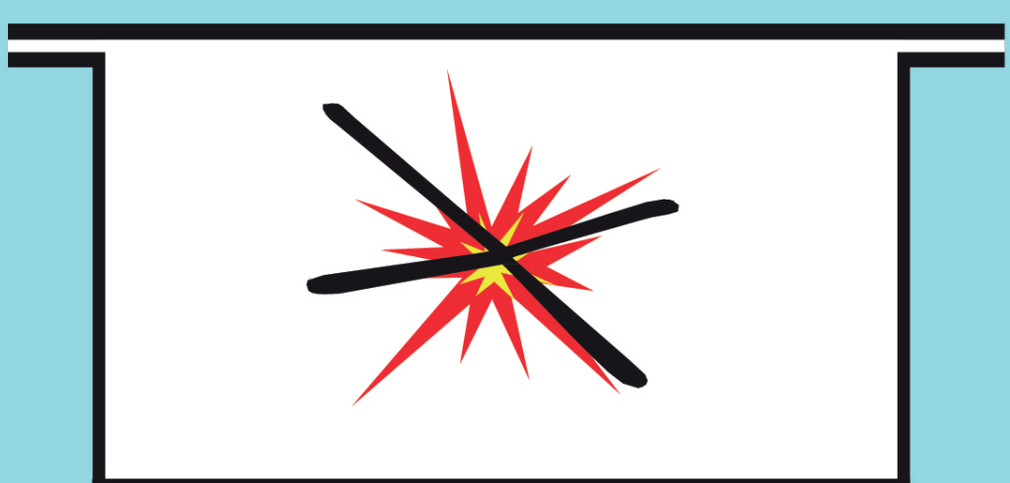
Electrical connections
In accordance with the requirements, electrical connections are subdivided into those for field wiring and factory wiring and into permanent types and reconnectable/rewireable types. Each type shall, as applicable, be constructed in such a way that the conductors cannot slip out from their intended location during the tightening of a screw or after insertion, provide a means to avoid self-loosening of the connection in service, be designed in such a way that contact is assured without damage to the conductors and to provide a positive compression force to assure contact pressure in service. If intended for stranded conductors, employ a means to protect the conductors and distribute the contact pressure evenly.

Degree of protection provided by enclosures
Enclosures containing bare conductive live parts shall provide at least the degree of protection IP54. The degree of protection IP44 is sufficient for enclosures that only contain insulated conductive parts. If rotating electrical machines in clean environments are monitored regularly by qualified personnel, the degree of protection IP 20 is sufficient for Group II.

Surface temperatures
With this type of protection the ingress of an explosive gas atmosphere cannot be excluded. This reason, the maximum permissible surface temperatures also apply to all surfaces inside an enclosure.

Electrical machines
Every insulating material is subject to a natural ageing process. To extend the service life of insulating materials used for windings, the limiting temperature is lowered compared to conventional windings. This reduces the risk of damage to the windings and, consequently, the formation of arcs and sparks due to earth faults and shorted windings. To protect the winding and to maintain the maximum permissible surface temperatures, current-dependent safety devices that respond in the event of heavy starting or malfunctions are generally used in motors. With motors with the level of protection “eb”, this protective device shall ensure that a motor that has reached its con tenuous service temperature after several hours of operation at rated load is still switched off safely before it reaches the permissible limiting temperature if a rotor blocks due to a malfunction and, as a result, the consumption of an increased current. Electrical motors in the type of protection “Increased Safety“ may generally only be used in continuous operation and for normal, not frequently recurring starts, so that the temperature increases occurring at the start do not exceed the permissible limiting temperatures.

Principle of the type of protection “Increased safety”



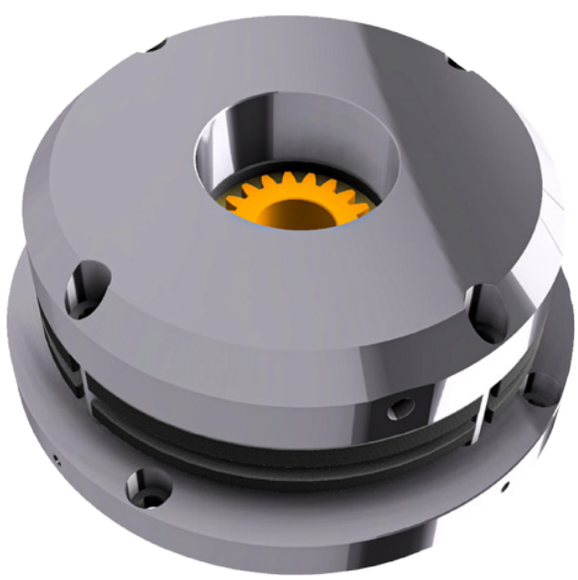
Junction and connection boxes
Rated data shall be specified for junction and terminal boxes to ensure adherence to the limiting temperature during operation. These can, for example, be specified by determining the load data in relation to the terminal cross section (wire cross-section) and the number of connected wires.

Examples of Increased Safety “e” applications
Three-phase cage rotors, transformers, current and voltage transformers, measuring instruments, luminaires, terminal compartments for all electrical equipment, connections for plugs and sockets.

EN 60079-18
EXPLOSIVE ATMOSPHERES – PART 18
EQUIPMENT PROTECTION BY ENCAPSULATION “M”

Scope

This part 18 of IEC 60079 gives the specific requirements for the construction, testing and marking of electrical equipment, parts of electrical equipment and Ex components with the type of protection encapsulation “m” intended for use in explosive gas atmospheres or explosive dust atmospheres. It only applies for encapsulated electrial equipment, encapsulated parts of electrical equipment and encapsulated Ex components (hereinafter always referred to as “m” equipment) where the rated voltage does not exceed 11 kV. The use of electrical equipment in atmospheres, which may contain explosive gas as well as combustible dust simultaneously, may require additional protective measures. This standard does not apply to dusts of explosives which do not require atmospheric oxygen for combustion or to pyrophoric substances and does not take account of any risk due to an emission of flammable or toxic gas from the dust. It supplements and modifies the general requirements of IEC 60079-0.



Definition

Type of protection whereby parts that are capable of igniting an explosive atmosphere by either sparking or heating are fully enclosed in a compound or other permitted non-metallic enclosure with adhesion in such a way as to avoid ignition of a dust layer or explosive atmosphere under operating or installation conditions.

Equipment protection level (EPL)

Electrical equipment in the type of protection encapsulation “m” can be designed with various levels of protection which determine the overall equipment protection level:
a) Level of protection „ma“ (EPL „Ma“ or „Ga“);
b) Level of protection „mb“ (EPL „Mb“ or „Gb“); c) Level of protection „mc“ (EPL „Gc“).

Additional requirements for level of protection “ma” and “mb”

Components without additional protection shall be used only if they cannot damage the encapsulation mechanically or thermally in the case of any fault conditions specified in this standard.

Additional requirements for level of protection “ma”

The working voltage at any point in the circuit shall not exceed 1 kV. Cells and batteries shall additionally comply with the cell and battery requirements of IEC 60079-11.; however, parallel cells are not permitted.

General requirements

Durometers, thermoplasts and elastomers with and without fillers and/or other additives may be used as the compound. The selection of the compound for a particular application depends on the function to be fulfilled by the compound in the equipment.

The encapsulation shall ensure the effectiveness of the type of protection subject to the level of protection, even in the event of permissible overloads and given faults. Voids in the compound for accommodating components such as relays, transistors, etc. are permissible. Specially designed multilayer circuit boards are also classed as encapsulated.

Principle of encapsulation “m”

Permissible free space in the encapsulation
With Group III equipment the sum of the free spaces is not limited, but the volume of each individual free space is limited to 100 cm3. The thickness of the compound surrounding such free spaces shall meet the requirements laid down in the standard.

With Group I and Group II equipment the sum of the free spaces shall not exceed:
• 100 cm3 for level of protection “mb” and “mc”,
• 10 cm3 for level of protection “ma”

Cells and batteries
Cells and batteries that can release gas during normal operation are not permitted. If for levels of protection “ma” and “mb” the release of gas in the event of a fault cannot be precluded, the gassing shall be minimised by a control device with secondary cells, the control device shall be effective not only during charging, but also during discharging.

INSTALLATION AND OPERATION OF ELECTRICAL EQUIPMENT IN HAZARDOUS AREAS

This chapter provides basic information on the installation and operation of electrical systems in Ex areas.

OPERATOR, INSTALLER AND MANUFACTURER OBLIGATIONS

Safety in hazardous areas can only be ensured by a close and effective working relationship among all parties involved (operator, installer, manufacturer, inspection authoriry, standardisation, public authority).

The operator is responsible for the safety of its equipment. It is their duty to judge where there is a risk of explosion and then classify zones accordingly. The operator must ensure that the system is installed correctly and tested before first-time commissioning. The system must be kept in proper working order by regular inspection and maintenance.

The requirements for system operation in hazardous areas are defined in the national regulations. In Europe minimum requirements are stipulated in EC Directive 1999/92/EC. National regulations supply the specific requirements in the respective countries.

Various standards have been issued at international and european level (Table in the next page).

The installer must observe the installation requirements and select and install the electrical equipment correctly according to its intended use.

Manufacturers of explosion-protected equipment must ensure special quality assurance measures during production and that every piece of manufactured equipment complies with the approved construction type.

EXPLOSIVE ATMOSPHERE (GAS AND COMBUSTIBLE DUST)		
	IEC	**EN**
Classification of areas - Explosive gas atmospheres	IEC 60079-10-1	EN 60079-10-1
Classification of areas - Explosive dust atmospheres	IEC 60079-10-2	EN 60079-10-2
Electrical installations design, selection and erection	IEC 60079-14	EN 60079-14
Electrical installations inspection and maintenance	IEC 60079-17	EN 60079-17
Equipment repair, overhaul and reclamation	IEC 60079-19	EN 60079-19

AREA CLASSIFICATION AND SELECTION OF EQUIPMENT

Potential explosion hazards are addressed at an early stage in the planning of new systems. When classifying hazardous areas both the strength of potential sources of ignition for combustible substances and the influence of natural or artificial ventilation must be taken into account. The explosion safety characteristics of the combustible substances used must be determined (see table in page 51). Only then can a decision be reached on the classification of explosive areas into zones and the selection of suitable equipment.

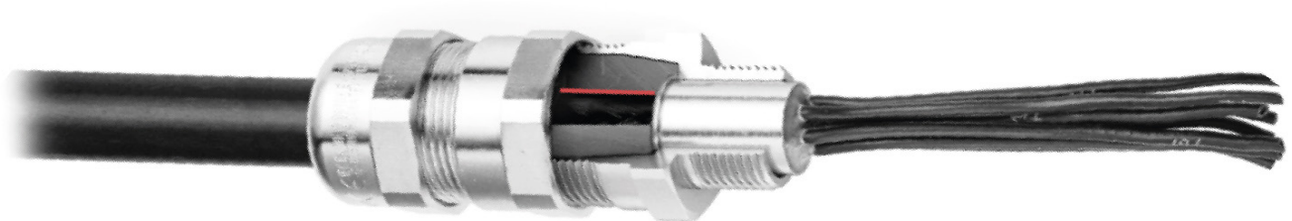
Equipment may only be used in the ambient temperature range specified in its marking. If the marking does not contain any information, the standard range of -20 °C to +40 °C applies. Electrical equipment must comply with the subgroup IIA, IIB or IIC. It must be selected and installed so that it is protected from external influences that may compromise explosion protection.

INSTALLATION TECHNIQUES

In the main, three installation systems are used for electrical systems in hazardous areas:
- Cable system with indirect entry.
- Cable system with direct entry.
- Conduit system.

The technical design of the electrical equipment implemented in the individual types of installation varies accordingly.

Cable systems
In Europe cable systems are most common, with high-quality cables and lines laid uncovered. It is only in areas in which mechanical damage is likely that they are laid in conduits, which are open at both ends.



In the case of indirect entry the cables and lines are run via cable entries into an “increased safety” protection type wiring area, where they are connected to terminals also designed for the increased safety protection type. The individual wires are then run via flameproof line bushings into the flameproof enclosure. In contrast to direct entry, the cable bushings are installed by the manufacturer so that the entire flameproof enclosure can be tested at the factory. The installer needs to only open the wiring area, but not the flameproof enclosure, for connection purposes.

In the case of direct entry the connecting lines are directly led into the flameproof enclosure. Only cable glands that have been specially designed and approved for this type of entry may be used. The flexible gasket and the cable sheath must form a flameproof joint. Care should therefore be taken to ensure that the right cable gland is selected for the type and structure of the cable and where it is used. In the event of an explosion in the flameproof enclosure the cable must withstand the explosion, so special requirements are placed on the gaskets.

Until Edition 2007 of IEC 60079-14, a selection matrix was applied to define when additional sealing compound was required in the screw fitting according to gas group, zone and enclosure volume. The matrix was superseded by IEC 60079-14 in 2013. Screw fittings with sealing compound should continue to be used. However, this is not required if a round tight cable with a minimum length of 3 m is used in conjunction with a screw fitting approved for flameproof enclosures. At this point, the flameproof enclosure depends on the care taken by the installer on laying the cables and lines.

Conduit system

In the case of conduit system installations, the electrical lines are run as single wires into enclosed metal conduits. The conduits are connected to the enclosures by means of screw fittings and sealed at every entry. The entire conduit system is flameproof. The aim of the seal is to prevent explosions which may occur inside the enclosure from penetrating the pipes. Otherwise, extremely high explosive pressures would be created as a result of pre-compression in long cylindrical tubes. For this reason, it is recommended that seals be installed not just at the entries, but also at specific intervals. Drains must be installed at low points where condensate can accumulate.

INSPECTION AND MAINTENANCE

Regular maintenance is required to maintain the safety of electrical systems in hazardous areas. The personnel performing such maintenance work must be supervised by an explosion protection expert and be informed of the special hazards. Before modification and maintenance jobs, it must be ensured that there is no risk of explosion during this work. Usually, official written permission must be obtained from the management. A report documenting the work performed should be drafted on completion. In addition it must be confirmed that all relevant regulations were observed. When replacing components or entire pieces of equipment, the explosion and equipment specifications should be noted.

THIS PUBLICATION AFFORDS AN INITIAL INSIGHT INTO THE EXTENSIVE FIELD OF EXPLOSION PROTECTION. WE WILL BE PLEASED TO ANSWER ANY QUESTIONS YOU MAY HAVE.

APPENDIX

ENCLOSURE PROTECTION TYPES ACCORDING TO IEC 60529 - IPXX

Reference	First number Touch protection	Foreign body	Second number Water protection
0	No protection	No protection	No protection
1	Protection from contact with back of hand	Protection from solid foreign bodies 50 mm Ø	Protection from water dripping straight down
2	Protection from contact with fingers	Protection from solid foreign bodies 12.5 mm Ø	Protection from water dripping down at an angle
3	Protection from contact with tools	Protection from solid foreign bodies 2.5 mm Ø	Protection from spray water up to 60°
4	Protection from contact with wire	Protection from solid foreign bodies 1.0 mm Ø	Protection from splash water from all directions
5	Protection from contact with wire	Dust-protected	Protection from hose water (IP x5)
6	Protection from contact with wire	Dustproof	Protection from strong hose water (IP x6)
7			Protection against intermittent immersion in water
8			Protection against continuous immersion in water

ENCLOSURE PROTECTION TYPES ACCORDING TO NEMA STANDARDS

Reference	Protection type	Installatio site
Type 1	Protection against accidental contact with live parts.	Interior
Type 2	Protection against penetration of dripping water and falling dirt.	Interior
Type 3	Protection against swirling dust, rain and hail. No damage from ice formation on enclosure.	Open air
Type 3R	Protection against penetration of hail, swirling dust and rain. External mechanisms stay operational when iced-over.	Open air
Type 4	Protection against falling rain, splashing water and hose water. No damage from ice formation on enclosure.	Interior or open air
Type 4X	Protection against falling rain, splashing water and hose water. No damage from ice formation on enclosure.	Interior or open air
Type 5	Protection from dust and falling dirt and dripping non-corrosive liquids.	Interior
Type 6	Protection from penetration of dust and hose water and water during temporary submersion. No damage from ice formation on enclosure.	Interior or open air
Type 6P	Protection from penetration of dust and hose water and due to prolonged submersion in water. No damage from ice formation on enclosure.	Interior or open air
Type 7	For installation in hazardous areas classified as Class I, Groups A, B, C or D.	Interior
Type 8	For installation in hazardous areas classified as Class I, Groups A, B, C or D.	Interior or open air
Type 9	For installation in hazardous areas classified as Class II, Groups E, F or G.	Interior
Type 10	Enclosure which complies with the Mine Safety Health Administration requirements.	Mining
Type 11	Protection from the corrosive effects of liquids and gases by oil immersion.	Interior
Type 12, 12K	Protection from penetration of dust, dirt and dripping liquids.	Interior
Type 13	Protection from dust, hose water, oil and non-corrosive liquids.	Interior

MARKING OF ELECTRICAL EQUIPMENT

Type of protection	Symbol alternative	Zone	Main application	Standard
Increased safety “e”	eb ec	1 2	Terminals and terminal boxes, squirrel cage rotors, lights	IEC 60079-7 EN 60079-7
Flameproof enclosure “d”	da db dc	0 1 2	Switchgear and control gear, command and display devices, motors	IEC 60079-1 EN 60079-1
Pressurised enclosure “p”	pyb pyc pzc	1, 21 1, 21 2, 22	Switchgear and control cabinets, large motors	IEC 60079-2 EN 60079-2
Intrinsic safety “i”	ia ib ic	0, 20 1, 21 2, 22	Instrumentation and control technology, fieldbus technology, sensors, actors [Ex ib] = associated electrical equipment in safe area	IEC 60079-11 EN 60079-11
Liquid immersion “o”	ob oc	1 2	Transformers	IEC 60079-6 EN 60079-6
Powder filling “q”	q	1	Sensors, electronic components, electronic ballasts	IEC 60079-5 EN 60079-5
Encapsulation “m”	ma mb mc	0, 20 1, 21 2, 22	Sensors, electronic components	IEC 60079-18 EN 60079-18
Protection type “n”	nA nC nB	2 2 2	Electrical equipment for Zone 2	IEC 60079-15 EN 60079-15
Protection by enclosure “t”	ta tb tc	20 21 22	Switchgear and control gear, control, connection, and terminal boxes, motors, lights	IEC 60079-31 EN 60079-31

Firedamp-endangered areas		
Group I		Methane
Gas explosion hazardous areas		
Group II	IIA IIB IIC	Propane Ethylene Hydrogen
Dust explosion hazardous areas		
Group III	IIIA IIIB IIIC	Combustible lint Non-conductive dust Conductive dust

Gas explosion hazardous areas: temperature classes	
Group I	Methane
Gas explosion hazardous areas	
450°C 300°C 200°C 135°C 100°C 85°C	T1 T2 T3 T4 T5 T6
Dust explosion hazardous areas: surface temperature	
T ... °C (example: T 70°C)	

SAFETY DATA - IGNITION TEMPERATURE, TEMPERATURE CLASS AND GROUP

Substance designation	Ignition temperature	Temperature class	Group
1.2 dichloroethane	440°C	T2	II A
Acetaldehyde	155°C	T4	II A
Acetone	535°C	T1	II A
Acetylene	305°C	T2	II C[3]
Ammonia	630°C	T1	II A
Petrol fuels	220 to 300°C	T3	II A
Benzene (pure)	555°C	T1	II A
Cyclohexanone	430°C	T2	II A
Diesel fuels	220°C	T3	II A
Acetic acid	485°C	T1	II A
Acetic anhydride	330°C	T2	II A
Ethane	515°C	T1	II A
Ethyl acetate	470°C	T1	II A
Ethanol	400°C	T2	II B
Ethyl chloride	510°C	T1	II A
Ethylene	440°C	T2	II B
Ethylene oxide	435°C (self-decomposing)	T2	II B
Ethyl ether	175°C	T4	II B
Ethyl glycol	235°C	T3	II B
Fuel oil EL, L, M, S	220 to 300°C	T3	II A
i-Amyl acetate	380°C	T2	II A
Carbon monoxide	605°C	T1	II A
Methane	595°C	T1	II A
Methanol	440°C	T2	II A
Methyl chloride	625°C	T1	II A
Naphthalene	540°C	T1	II A
n-Butane	365°C	T2	II A
n-Butanol	325°C	T2	II B
n-Hexane	230°C	T3	II A
n-Propyl alcohol	385°C	T2	II B*
Phenol	595°C	T1	II A
Propane	470°C	T1	II A
Carbon disulphide	95°C	T6	II C[1]
Hydrogen sulphide	270°C	T3	II B
Toluene	535°C	T1	II A
Hydrogen	560°C	T1	II C[2]

*The explosion group for this substance has not yet been determined.
[1] Also explosion group II B + CS2. [2] Also explosion group II B + H2. [3] Also explosion group II B + C2 H2.

EQUIPMENT GROUP I: MINING - EQUIPMENT GROUP II: OTHER AREAS							
Classification	**Zone 0**	**Zone 20**	**Zone 1**	**Zone 21**	**Zone 2**	**Zone 22**	**Mining**
Hazardous explosive atmosphere	Constantly, frequently or long term		Occasionally		Seldom and short term		
Equipment category	1G	1D	2G	2D	3G	3D	M1 or M2

EQUIPMENT CATEGORY AND EQUIPMENT PROTECTION LEVEL (EPL)							
Classification	**Zone 0**	**Zone 20**	**Zone 1**	**Zone 21**	**Zone 2**	**Zone 22**	**Mining**
EPL (IEC/EN 60079-0)	**Ga**	**Da**	**Gb**	**Db**	**Gc**	**Dc**	**Ma or Mb**

MARKING OF NON-ELECTRICAL EQUIPMENT

Type of protection	Symbol standard	Zone	Main application	Standard
Constructional safety “c”	h	0, 1, 2 20, 21, 22	Couplings, pumps, gear drives, conveyor belts	ISO 80079-37 EN ISO 80079-37
Control of ignition source “b”	h	0, 1, 2 20, 21, 22	Pumps, conveyor belts	ISO 80079-37 EN ISO 80079-37
Liquid immersion “k”	h	0, 1, 2 20, 21, 22	Submerged pumps, gears	ISO 80079-37 EN ISO 80079-37
Flameproof enclosure “d”	h	1, 2	Brakes, couplings	IEC 60079-1 EN 60079-1
Pressurised enclosure “p”	h	1, 2 21, 22	Pumps	IEC 60079-2 EN 60079-2
Protection by enclosure “t”	h	20, 21, 22	Equipment exclusively for dust explosion hazardous areas	IEC 60079-31 EN 60079-31

Firedamp-endangered areas		
Group I		Methane
Gas explosion hazardous areas		
Group II	IIA IIB IIC	Propane Ethylene Hydrogen
Dust explosion hazardous areas		
Group III	IIIA IIIB IIIC	Combustible lint Non-conductive dust Conductive dust

Gas explosion hazardous areas: temperature classes	
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Gas explosion hazardous areas	
450°C 300°C 200°C 135°C 100°C 85°C	T1 T2 T3 T4 T5 T6
Dust explosion hazardous areas: surface temperature	
T ... °C (example: T 70°C)	

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Directive 2014/34/EU of the European Parliament and the Councilof 26 February 2014 on the harmonisation of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres (recast).

Directive 94/9/EC of the European Parliament and the Council of 23 March 1994 on the approximation of the laws of the Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres.

Directive 1999/92/EC of the European Parliament and of the Council of 16 December 1999 on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres (15th individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC).

IEC 60079 Part 0 to 46
Explosive atmospheres
www.webstore.iec.ch

EN 60529
Degrees of protection provided by enclosures (IP-Code)
www.cenelec.eu

EN 13463 Part 1 to 8
Non-electrical equipment for use in potentially explosive atmospheres
www.cenelec.eu

ISO 80079 Part 36, 37
Explosive atmospheres – Non-electrical equipment for explosive atmospheres
www.webstore.iec.ch

EN 1127 Part 1 and 2
Explosive atmospheres - Explosion prevention and protection
www.standards.cen.eu

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Components

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